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150 YEARS OF NEANDERTHAL DISCOVERIES

EARLY EUROPEANS - CONTINUITY & DISCONTINUITY

July 21st – 26th, 2006 in Bonn, Germany

Congress

Program and Abstracts

universitätbonn

DEUQUA Deutsche Quartärvereinigung

TERRA NOSTRA 2006/2

150 YEARS OF NEANDERTHAL DISCOVERIES

EARLY EUROPEANS - CONTINUITY & DISCONTINUITY

21 - 26 July, 2006 in Bonn

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Introduction

The Rheinische Friedrich-Wilhems-Universtät in Bonn is proud to host the international congress "150 Years of Neanderthal Discoveries" with its symposia devoted to the most significant topics of research on this extinct European human population.

Over the past century and a half, the city of Bonn has maintained a close relationship with the classical skeleton found in 1856 in the Neanderthal near Düsseldorf. The former Provinzialmuseum, now the Rheinisches LandesMuseum, bought the skeleton in 1877 and the skull has been exhibited there ever since. But the ties between the City and the Neanderthal fossil extend far beyond this physical presence of the specimen in Bonn: J. Carl Fuhlrott, a former student at the University of Bonn, was the first scientist to recognize the fact that Neandertal indeed represents an extinct human fossil different from modern humans. His revolutionary insight was supported by Hermann Schaafhausen, a professor of anatomy at the University of Bonn. That such ideas were by no means generally accepted at the time is attested by a brief note added to Fuhlrott's paper in 1859 by the editor of the *Verhandlungen des naturhistorischen Vereines der preussischen Rheinlande und Westphalens*. He explained in this note that the Journal had decided to publish this paper in its totality even if its editorial committee totally disagreed with its content.

The Feldhofer Grotte where the Neanderthal bones were found was destroyed when the Devonian Limestone of the valley was quarried. It is of great significance that in 1997 Ralph Schmitz and J. Thissen recovered the former sediments which were cleared out of the cave. In these sediments they even found bone fragments that matched the classical skeleton, as well as remains of two other individuals. The recent discovery was supported by the Rheinisches Amt für Bodendenkmalpflege in Bonn.

Fifty years ago, to commemorate the centenary of the discovery of the original Neanderthal fossil, G.H.R. v. Koenigswald organized a congress in Düsseldorf. This centenary congress focused on the morphological description and the phylogenetic position of the Neanderthals, which at that time were believed to have been present throughout the ancient world. In the present state of our research, we know that the Neanderthals were present in a much more limited geographical region, in Europe and the Near East. In our contemporary scientific context, recent important discoveries of much more archaic specimens in Africa and Asia has focused attention on the earliest forms of human life, which places in a new temporal and evolutionary perspective discoveries in other, more recent periods. Moreover, our interest in Neanderthal evolution today has become much more varied and focuses on the life history of the Neanderthal population, on their subsistence, their technology, their social organization and their capacity for environmental adaptation. New dating methods allow a much more reliable stratigraphic analysis. The question concerning the phylogenetic status of Neanderthals and their relation to modern humans is now also examined not only in light of their anatomical particularities, but also of paleogenetic investigations.

Under the auspices of UNESCO and of the Minister-President of the German Land Nordrhein-Westfalen, 2006 has been declared the "Year of the Neanderthals". Four major events celebrate this jubilee: three exhibitions and a congress. In chronological sequence of their openings the exhibitions are "Close Encounters. Neanderthals – Hautnah" at the Neanderthal Museum in Mettmann, "climate and mankind. life in eXtremes – Leben in eXtremen" at the Westfälisches Museum für Archäologie in Herne, and the exhibition "Roots – Wurzeln der Menschheit" at the Rheinisches Landesmuseum in Bonn.

The congress was organized together with DEUQUA by the Institut für Paläontologie at the University of Bonn (Prof. W. v. Koenigswald and Prof. T. Litt) with the help of the CNRS, France (Dr. S. Condemi) and the Senckenberg Museum, Frankfurt am Main (Prof. F. Schrenk).

We are most pleased that more than 200 scientists from 17 countries have accepted our invitation to participate in this congress in order to discuss the most recent aspects of the interpretation of Neanderthals and future perspectives in Neanderthal study.

We would like to extend our thanks to our different sponsors whose generous financial support has made this scientific event possible:

- Alexander von Humboldt-Stiftung, Bonn
- Deutsche Forschungsgemeinschaft, Bonn
- Deutsche Post AG, Bonn
- Gesellschaft der Freunde und Förderer der Universität Bonn
- Landschaftsverband Rheinland
- Ministerium für Wissenschaft und Forschung des Landes NRW, Düsseldorf
- Rektorat der rheinischen Friedrich-Wilhelms-Universität zu Bonn
- Stiftung Internationale Begegnung der Sparkasse in Bonn
- Stadt Bonn

Our very special thanks to the persons of the Institut für Paläontology who helped to prepare this abstarct volume and the Congress.

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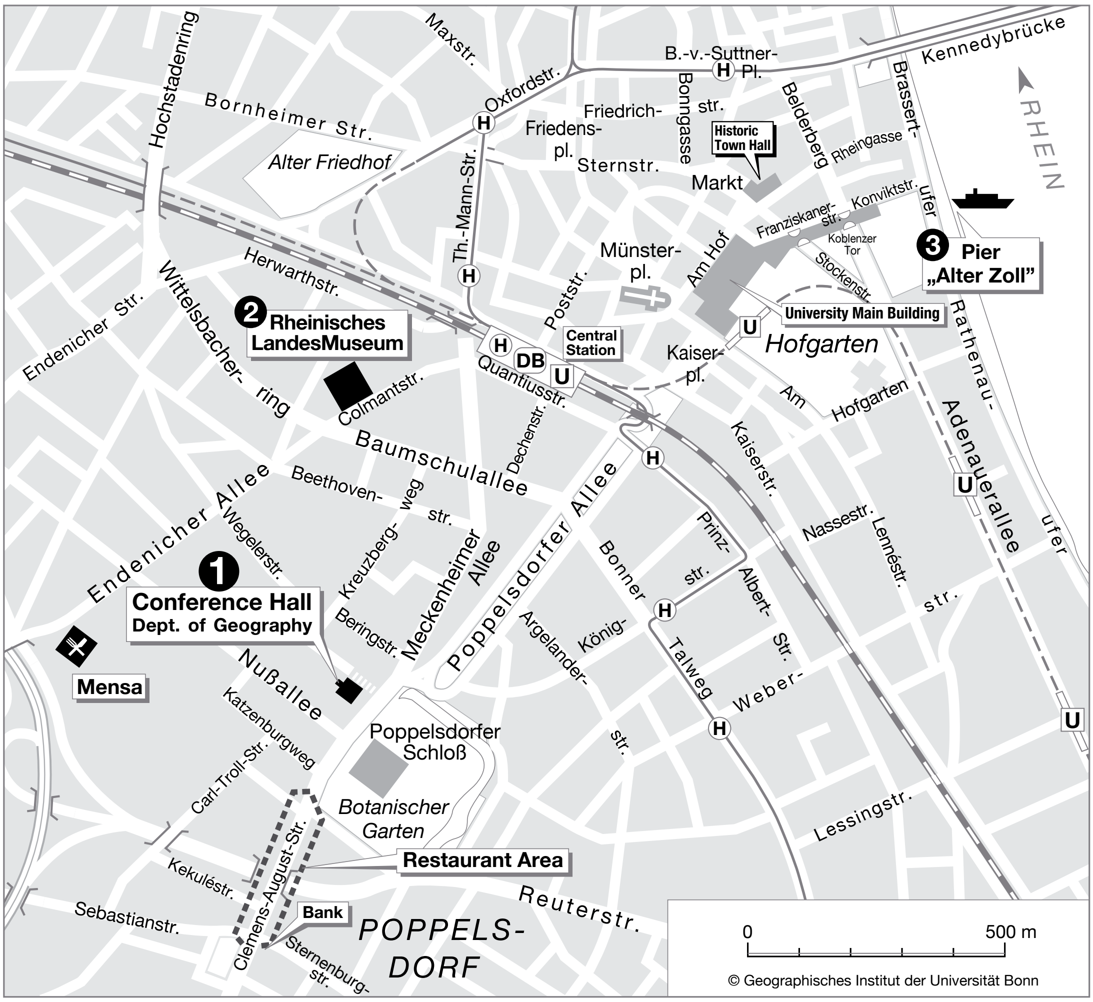

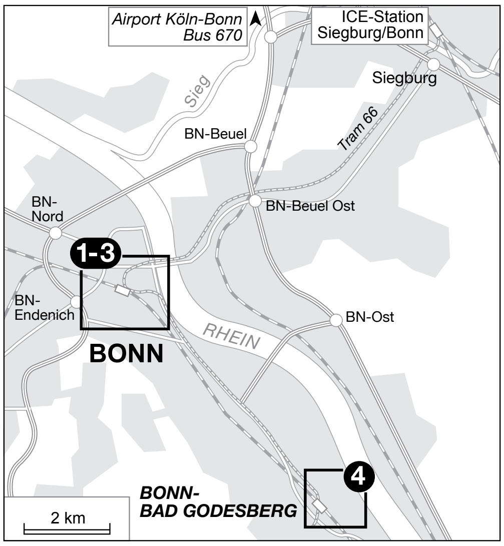

❶ **Department of Geography**, Meckenheimer Allee 166:
Registration office, Lecture hall, Posters, Departure for excursions (22 - 26 July).

❷ **Rheinisches LandesMuseum**, Colmantstraße :
Opening Ceremony and Ice Breaker Party (21 July) and Public Lecture (22 July).

❸ **Pier "Alter Zoll"**: Departure for the Congress Dinner (23 July).

❹ **Alexander v. Humboldt Stiftung**, Jean-Paul-Str. 12:
Reception after the excursion (24 July).

Program

Friday July 21, 2006

DEUQUA- excursion to the Pleistocene volcanic field in the Eastern Eifel.
Depature at 8:30 h at the University of Bonn, Geographisches Institut, Meckenheimer Allee 166. Return in time for the opening ceremony (guide: HANS-ULRICH SCHMINCKE)

In the Rheinisches LandesMuseum Bonn, Colmantstrasse 14
16:00 h Registration and visit of the exhibition “Roots - Wurzeln der Menschheit”
18:30 h Opening ceremony and snacks
20:30 h Introduction lecture F. CLARK HOWELL: Neanderthals and Emergent Paleoanthropology Fifty Years Ago.

Saturday July 22, 2006

University of Bonn, Geographisches Institut, Meckenheimer Allee 166

8:30 – 12:30 Symposium 1: Outside Europe and Neanderthal Origins
Conveners: SILVANA CONDEMI & FRIEDEMANN SCHRENK - Respondent: IAN TATTERSALL

1.1 CHRIS STRINGER: The Middle Pleistocene Records of Western Eurasia and Africa, and the Evolution of Neanderthals and Modern Humans
1.2 LIU WU: The Hominid Fossils from China Contemporaneous to the Neanderthals and some Related Studies
1.3 NAAMA GOREN-INBAR: Behavioral and Cultural Origins of Neanderthals: A Levantine Perspective
1.4 FRANCESCO MALLEGNI: The Earliest European Peopling after the Recent Discoveries: Early Neanderthals or Different Lineages?

14:00 – 18:00 Symposium 2: Neanderthal Palaeoenvironment
Conveners : WIGHART v. KOENIGSWALD & THOMAS LITT - Respondent: CLARK F. HOWELL

2.1 CHRONIS TZEDAKIS: Climate Change and Vegetation Response in the Mediterranean During the Middle and Late Pleistocene.
2.2 THOMAS LITT: Climatostratigraphy and Paleoecology of the Middle and Upper Pleistocene in North-Central Europe Based on Paleobotanical Data
2.3 TASSOS KOTSAKIS: Evolution of the Vertebrate Pleistocene Faunas in the Mediterranean Area.
2.4 WIGHART V. KOENIGSWALD: Climatic Changes, Faunal Diversity, and Environment of the Neanderthals in Central and Western Europe During the Middle and Upper Pleistocene
2.5 ANDREY SHER: Pleistocene Faunal and Environmental Evolution in Siberia: Adding a North-eastern Dimension to the European Story.- Page 40

20:00 Public lecture at the LandesMuseum Bonn (Colmantstrasse 14):
RALF W. SCHMITZ: Neue Ergebnisse zam namengebenden Neanderthaler und zu seiner wiederentdeckten Fundstelle. (New Results on the Neanderthal Type Specimen and on the Rediscovered Locality).

Sunday July 23, 2006

University of Bonn, Geographisches Institut, Meckenheimer Allee 166

8:30 – 12:30 Symposium 3: Neanderthal lifeways, subsistence and technology
Conveners: NICHOLAS CONARD & JÜRGEN RICHTER - Respondent: PAUL A. MELLARS

3.1 HERVÉ BOCHERENS: Diet and Ecology of Neanderthals
3.2 ERIC BOEDA: Neanderthal Lithic Technology
3.3 CLIVE GAMBLE: Social Organization and Settlement Dynamics of Neanderthals
3.4 SABINE GAUDZINSKI-WINDHEUSER: Neanderthal Subsistence Behaviour in Northwestern Europe
3.5 STEVEN LOUIS KUHN: The Economics and Organisation of Neanderthal Technology

14:00 – 18:00 Postersession **1**

14:00 – 18:00 DEUQUA Sessions
Conveners: FRANK PREUSSER & ERNST BRUNOTTE

Rhine session
D1.1 GERALD GABRIEL et al.: The Heidelberg Drilling Project (Upper Rhine Graben, Germany)
D1.2 PETER FISCHER & ERNST BRUNOTTE: Late Quaternary Landscape Evolution and Soil Formation in the Range of the Loess Covered Middle Terraces in the Central Lower Rhine Embayment
D1.3 HANS AXEL KEMNA: Pliocene and Early Pleistocene Chronostratigraphy of Middle and Northwestern Europe Based on Pollen Analysis: an Errant Concept and a New Approach
D1.4 ANDREAS DEHNERT: Burial Dating of Fluvial Sediments from the Lower Rhine Embayment, Germany
D1.5 F.S. BUSSCHERS: Imprints of Climate Change, Sea-level Oscillations and Glacio-hydro-isostacy in the Rhine-Meuse Sedimentary Record (the Netherlands)

Archeological sites
D1.6 DANIELA C. KALTHOFF: The Fossil Vertebrate Fauna from the Neanderthal – Results and Problems of New Findings from the Type locality of *Homo neanderthalensis*
D1.7 ULRICH HAMBACH et al. : Magnetic Susceptibility Stratigraphy and Enviromagnetics of Middle to Upper Palaeolithic Cave Sediments from Southern Germany (Hunas Cave Ruin, Franconia and Hohle Fels, Swabia)
D1.8 MARKUS FIEBIG et al.: Human Palaeoenvironment in the Eastern Alps During the Last Glacial Cycle

19:00 h boarding and 19:30 h departure at pier near the "Alter Zoll" for the Congress-Dinner in a River boat "Wappen von Bonn" on the Rhine

Monday July 24, 2006

8:30 h depature for both excursions at the University of Bonn, Geographisches Institut, Meckenheimer Allee 166.

Excursion to type locality in the Neanderthal and the exhibitions "Close Encounters. Neanderthals – Hautnah" at Neanderthal Museum in Mettmann and "climate and mankind. life in eXtremes - Leben in eXtremen" at the Westfälische Museum in Herne.

DEUQUA- excursion to the Pleistocene volcanic field in the Western Eifel (Guide: THOMAS LITT).

Both excursions will end at the reception of the Alexander von Humboldt-Stiftung, Bonn-Bad Godesberg, Jean-Paul Str. 12 at 18:00h.

Tuesday July 25, 2006

University of Bonn, Geographisches Institut, Meckenheimer Allee 166

8:30 – 12:30 Symposium 4: Neanderthal Anatomy, Adaptation, Physical and Cultural Variations
Conveners: SILVANA CONDEMI & WINFRIED HENKE - Respondent: PATRICIA SMITH

4.1 JEAN-JACQUES HUBLIN: Neanderthal as an Other Humankind: Where are we now?
4.2 ANNE-MARIE TILLIER: Palaeauxology Applied to Neanderthals
4.3 PATRICIA SMITH et al.: Computerized Reconstruction of Prenatal Growth Trajectories in the Dentition: Implications for the Taxonomic Status of Neandertals
4.4 LESLIE AIELLO: Neanderthals, Energetics and Evolution
4.5 BERNARD VANDERMEERSCH & MARIA DOLORES GARRALDA: The Geographical and Chronological Variation of the Neanderthals.

14:00 – 18:00 Postersession 2

14:00 – 16:30 DEUQUA Session 2
Convener: MARGOT BÖSE

D2.1 FRANK PREUSSER & CHRISTIAN SCHLÜCHTER: Middle to Late Quaternary Stratigraphy of Switzerland and Correlation with High-resolution Marine Records
D2.2 BIRGIT TERHORST et al.: Loess/paleosol Sequences as Stratigraphical Database of the Brunhes Chron in Upper Austria
D2.3 BRIGITTE URBAN: Pleistocene Pollen Records from Schöningen, North Gremany
D2.4 NORBERT KÜHL et al.: Reconstruction and Comparison of the Climatic Evolution of Middle and Upper Pleistocene Warm Periods and the Holocene
D2.5 SVEN LUKAS et al.: Glaciation During the Younger Dryas in Europe's Mountains – an Overview of Climatic implications
D2.6 JÜRGEN M. REITNER et al. : The Sturzstrom Event of Feld (Matrei/Eastern Tyrol/Austria): A Forgotten Catastrophe During Early Human Settlement in the Alps?
D2.7 NAKI AKÇAR et al.: Cosmogenic Dating (Exposure and/or Burial) of Stone Artifacts: Additional Dating Tool in Archeology?
17:00 General assemblage of the DEUQUA members

20:00 Reception on the roof deck of LandesMuseum Bonn, Colmantstrasse 14 and
21:00 Presentation of movies related to early man

Wednesday July 26, 2006

University of Bonn, Geographisches Institut, Meckenheimer Allee 166

8:30 – 12:30 Symposium 5: Neanderthals and Modern Humans
Conveners: GERD-C. WENIGER & JÖRG ORSCHIEDT - Respondent: MILFORD WOLPOFF

5.1 SVANTE PÄÄBO: Neanderthal Genomics
5.2 OLAF JÖRIS et al.: Dating the Transition
5.3 ERIC TRINKAUS: Late Neandertals and Early Modern Humans: Biology, Behavior and Population Dynamics
5.4 JOÃO ZILHÃO: Patterns of Cultural Variability During the Middle-to-Upper Paleolithic Transition in Europe
5.5. ROBERTO MACCHIARELLI & GERD-CHRISTIAN WENIGER : NESPOS: From Data Accumulation to Data Management

14:00 - 16:00 Round Table discussion: Future Perspectives in the Study of Neanderthals
Awarding of poster prize and closing ceremony

Symposia

Symposium 1: Outside Europe and Neanderthal Origine

Conveners: SILVANA CONDEMI & FRIEDEMANN SCHRENK

Respondent: IAN TATTERSALL

Since the discovery of classical Neanderthal skeleton numerous fossil specimens have been found in various parts of Europe. These fossils have enabled us to show that Neanderthals were an autochthonous population in Europe and that the differentiation of this lineage occurred over a long period of time, which lasted at least 450.000 years. What is the relationship of the Neanderthal population and the early hominids discovered in Europe? What are its phylogenetic relations with populations known today in Africa and in Asia? Can one speak of a cultural particularity for the Neanderthals?

The Middle Pleistocene records of western Eurasia and Africa, and the evolution of Neanderthals and modern humans

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It is now generally agreed that the basic anatomy of *H. sapiens* was present in Africa by at least 150 ka. The fossil record between 100-250 ka has been expanded by new discoveries (e.g. Herto ~160 ka) or improved dating (Singa >130 ka; Guomde >150 ka; Omo Kibish ~195 ka; Florisbad ~260 ka) and there has also been parallel progress in deciphering the behavioural record of the Middle Stone Age. The extension of early modern humans to the Levant by 100 ka has been confirmed by further dating analyses on the Skhul and Qafzeh material, but evidence has also emerged that the Tabun C1 Neanderthal inhabited the region at around the same time. It thus seems likely that an overlap of the emerging modern and Neanderthal clades was a consistent feature of the region during the later Middle Pleistocene, as well as the early Late Pleistocene, and it is unfortunate that the Zuttiyeh and Tabun C2 fossils are so incomplete and enigmatic.

Despite the considerable progress made, we still have a long way to go in understanding the later stages of human evolution in Africa and western Eurasia. Given population size, long time scales and endemism, Africa probably always had more genetic and morphological variation than Eurasia. With repeated and substantial climatic (especially precipitation) fluctuations, populations would have expanded and overlapped, or been pushed into isolated refuges, many times over. Recent palaeoclimatic data suggest that major fluctuations of the monsoons in the tropics and subtropics followed much shorter timescales than simple 100 ka Milankovitch periodicity. It is still uncertain whether the pattern of modern human evolution in Africa was essentially continent-wide, or was a more localized phenomenon. African fossils from 100-250,000 years ago show a great deal of anatomical variation, and we are only sampling a tiny part of the whole continent's populations at present (there is no significant record from much of central and western Africa, for example, but we know people were there from lithic evidence). Did an early modern morphology evolve gradually and spread outwards from, say, East Africa, replacing more archaic forms? Or could there have been an African version of multiregionalism, with modern genes, morphology and behaviour coalescing from various populations across the continent? Better samples and dating of the records, and continuing genetic analyses, are needed to help resolve these fundamental questions, but there is growing molecular evidence of deep divisions within African populations, suggesting extensive periods of fission and fusion.

It certainly remains possible that the characteristic morphology of modern humans evolved in a mosaic fashion in Africa rather than as a package, which will provide problems of interpretation comparable with those faced in deciding on the classification of the Atapuerca SH sample in Europe (*heidelbergensis* or *neanderthalensis*?). In the latter case, the recognition of Neanderthal clade characters may justify the extension of *H. neanderthalensis* far back into the Middle Pleistocene (as with the Swanscombe skull), but it is very difficult to make a comparable case for extending the temporal range of *H. sapiens* back beyond the fossil records of Herto and Omo Kibish. Even here, the morphology of the Herto 1 and Omo 2 specimens poses problems of interpretation. The occipital region in both fossils resembles that seen in archaic crania assigned to *Homo heidelbergensis* or *Homo rhodesiensis*. But is this mosaic anatomy a primitive retention from more ancient ancestors, or a sign of gene flow from contemporaneous African populations that still retained such features? Dating in progress of African fossils from Ngaloba, Broken Hill, Jebel Irhoud and Dar-es-Soltan may elucidate this issue, as may further genetic evidence of deep structure in African populations.

In the last few years we have seen an accumulation of data which, in my view, strongly support the recognition of a distinct Neanderthal lineage with its own evolutionary history, one which warrants a species-level distinction based on morphology. This work includes comparative studies of Neanderthal ontogeny, cranial morphology and dental morphology. Molecular data (presently only mitochondrial) also supports a distinctive population history for Neanderthals, with estimated divergence dates from the modern human lineage consistent with those derived from palaeontology (Middle Pleistocene ~ 500 ka). However, both the molecular divergence and the appearance of the first apomorphies probably provide a maximum age for any species separation, and it may be safer to consider the Neanderthal-*sapiens* relationship at the level of allotaxa (*sensu* Grubb 1999), as already argued by Jolly.

Although late Pleistocene events such as the dispersal of modern humans and the extinction of the Neanderthals attract most academic and popular attention, it should be remembered that these were only the endpoints of hundreds of millennia of possible competition and interaction between the evolving Neanderthal and *sapiens* lineages, with the Levant a long-term potential region of contact. Looked at through time, the repeated lack of palaeontological or archaeological visibility of both lineages suggests that they regularly underwent local extinctions, and these were probably caused by many different factors. Equally, the interactions of these populations over that time may well have run the whole gamut of possible scenarios from avoidance, competition or conflict, through coexistence with little contact, to peaceful interactions and even hybridisation. Nevertheless, the terminal lineages of *H. neanderthalensis* and *H. sapiens* appear quite distinct from the palaeontological record, reflecting the dominance of vicariance over gene flow in their evolutionary histories.

The hominid fossils from China contemporaneous to the Neanderthals and some related studies

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The main hominid fossils contemporaneous to the Neanderthals

Since the initial discovery of hominid fossils at the beginning of the 20th century, more than 70 hominid sites have found in China. These fossils have been attributed to either *Homo erectus* or *Homo sapiens*. Among them, most of the fossils were found from the middle to late Pleistocene deposits and their chronological ages are approximately contemporaneous to the Neanderthal lineages of Europe. Among them, Hexian, Dali, Jinniushan, Maba, Xujiayao and Chaoxian are more important because of their well preserve condition and great numbers. Table 1 lists some important middle hominid fossils found in China.

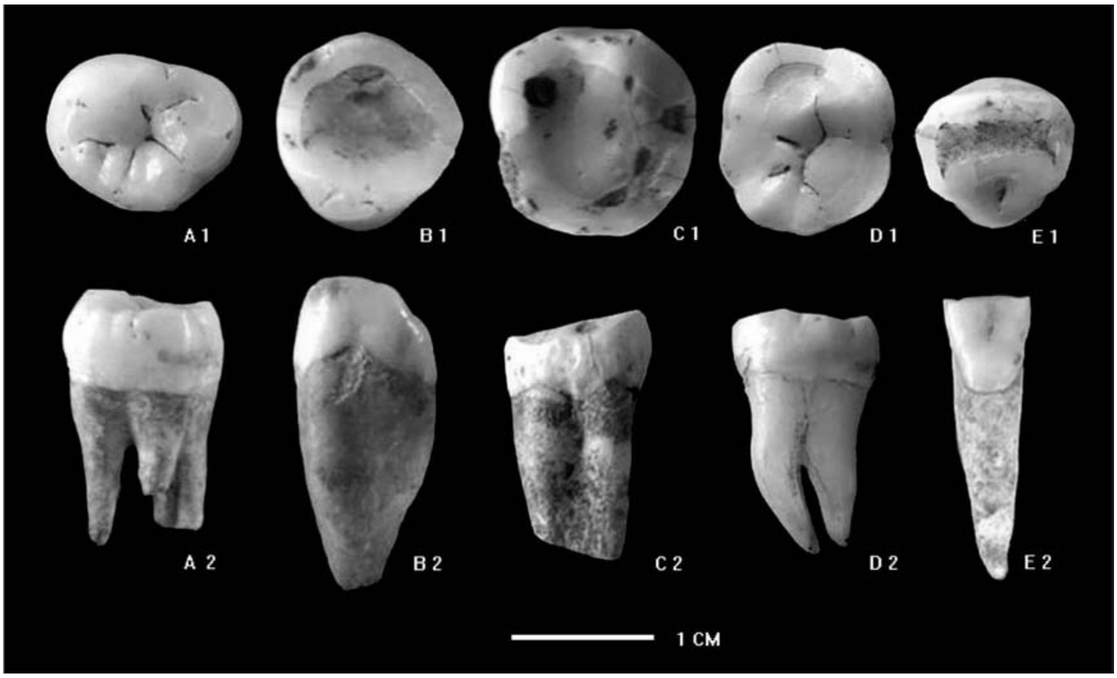
Some recent studies

More recently, with the advances in the research of modern human origins in East Asia, more attentions have been paid to the studies of late Pleistocene human evolution in China. A series of field work and specimen studies have been carried out by Chinese colleagues. Some new late Pleistocene human fossils have been found and some traditional opinions on the late Pleistocene human evolution in China have been challenged.

Some studies of the middle and late Pleistocene hominid fossils of China revealed a group of common morphological features, including shovel-shaped incisors and flatness of the face characterizing the Pleistocene hominids in China. These common features have been used to support the regional continuity of human evolution in China. At the same time, a few features more commonly seen in the Neanderthal lineage are said to occur in some Chinese fossil skulls, which are claimed possible gene flow between China and Europe. Based on these studies, Wu Xinzhi proposed the hypothesis "continuity with hybridization" for human evolution in China. He believes the anatomically modern humans of East Asia originated most probably in China. However, these opinions and related studies are questioned by colleagues by the colleagues from both China and abroad. Recently, the present author and some other colleagues in China conducted some comparative studies trying to demonstrate the morphological basis for the gene flow between Chinese hominids and Neanderthals. Our preliminary results do not give supports for the Neanderthal influence to the Chinese hominids.

New hominid fossils in China

For many years, it has been generally believed that the ages of the most of the late Pleistocene human fossils found in China are not earlier than 50 kyr BP. Although some of the them have been thought as early as more than



The hominid teeth found from the Huanglong Cave in the west Hubei Province

50 kyr BP, nearly all the dating is in debates because of either the unclear stratigraphic layer yielding the human fossils or methodology. Some colleagues even questioned the existence of the hominids around 100 ka in China. With these backgrounds, a series of field work have been carried out in recent years, which led to some new human fossil discoveries. Among them, several new fossil sites found in the West Hubei and Three Gorge region are most important.

The west Hubei and Three Gorge region is a narrow region across the west part of Hubei Province with the Three Gorge area intermediate. Since the first discovery of a hominid maxilla fragment in Changyang in 1957, at least 10 hominid fossil sites have been found in this region, and among them the Yunxian *Homo erectus* and Longgupo sites are included. Except for the hominid fossil sites, more than 30 sites with stone artifacts

Sites	Main specimens	Geological epoch	Chronological dates
Hexian	1 skull cap, jaw bones and isolated teeth	Middle Pleistocene	270-150 ka
Dali	1 cranium	Middle Pleistocene	209 ka
Jinniushan	1 cranium, 6 vertebrae, os coxae, 1 ulna	Middle Pleistocene	280 ka
Maba	1 skull-cap	Middle Pleistocene	135-129 ka
Xujiayao	16 cranial fragments	Late Pleistocene	125-104 ka
Dingcun	3 teeth; 1 parietal	Late Pleistocene	210-160 ka
Tongzi	6 teeth	Late Pleistocene	181-113 ka
Chaoxian	1 occipital; 1 maxilla with left I^2, P^2-M^2 and right I^2, P^1-M^1	Middle Pleistocene	200-160 ka
Changyang	Left maxilla with P^1 and M1; isolated P_2	Middle Pleistocene	--
Meipu, Yunxian	4 isolated teeth	Middle Pleistocene	--
Xichuan	13 isolated teeth	Middle Pleistocene	--
Hunaglong Cave	5 teeth	Late Pleistocene	103-94 ka
Bailong Cave	4 isolated teeth	Middle Pleistocene	--

Table 1 The main human fossils of China contemporaneous to the Neanderthals

and other evidence showing human activities have also been located. Since 2000, our field surveys have found 4 new late Pleistocene hominid fossil sites. Some preliminary excavations have been carried out in these sites. All the four sites have hominid fossils, stone artifacts and mammal fossils unearthed. Among the four new sites, the hominid fossils from the Huanglong Cave and Xinglong Cave have been dated arounf 100 ka. The Huanglong Cave is located in the Yunxi County, which is in the northwest of Hubei Province. In 2004, our test excavation at the Huanglong Cave

Behavioral and Cultural Origins of Neanderthals: A Levantine Perspective

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The plenary session of the conference "150 years of Neanderthal discoveries – early Europeans: continuity and discontinuity" presents the current *state of the art* with respect to Neanderthals and their material culture in the Old World. This contribution will focus on some aspects of the background to the world of Neanderthals and their contemporaries. It draws mainly on the geographical meeting point – the Levantine Corridor – and will be concerned with the contribution that its study makes to a better understanding of the evolution and cultural background of the Neanderthals.

The understanding of Neanderthal material culture and behavioral traits requires insight into preceding times, which form the background to Neanderthal behavioral and techno-cultural abilities. Only a limited number of issues will be addressed here: knowledge of the environment and space and modes of their exploitation, colonization and mobility, hunting, first appearance of particular technological inventions and their contribution to hominin adaptive abilities.

Neanderthal discoveries have always been received with excitement and much scientific and lay interest. Over the years, many scholars have viewed these hominins as archaic and primitive creatures of limited abilities. This extremely influential view dictated that predecessors of the Neanderthals were perceived as creatures of even lesser cognitive abilities. This attitude led to denial of a multitude of indications and important data demonstrating that ancient and modern behavioral patterns share some fundamental traits and, furthermore, can be seen to evolve along a time trajectory. In addition, the Middle to Upper Paleolithic transition (with emphasis on the European record) and the disappearance of the Neanderthals have been a theme of extensive research, most likely because this involved our own species. In contrast, the transition from Acheulian and non-Acheulian Lower Paleolithic entities to those of the Middle Paleolithic took place ca. 250 Ka ago in the entire Old World and marks the shift from cultural entities assigned to ancient humans to those associated with archaic *Homo sapiens* and Neanderthals. Nevertheless, this earlier shift has been rather succinctly addressed and far less thoroughly investigated, and the cultural and behavioral aspects of this period are less well known. This situation stems from the lack of long sequences, taphonomic disturbance of sites, lack of suitable dating methods, and meager publications. To a certain extent, this is also the result of a lack of interest in this "unfashionable" issue. Despite all this, the available data illustrate continuity of behavioral traits in diverse fields. Fundamental behavioral traits such as the ability to identify and occupy particular (favorable) landforms, ecological niches and habitats, to successfully exploit diverse sources and to continuously survive in a given territory for a long time period are shared by Lower and Middle Paleolithic hominins. Furthermore, hominin behavioral patterns that emerged during pre-Neanderthal times were later adopted and frequently gained higher popularity and elaboration. This phenomenon is evident in the domains of both planning and implementation; among numerous topics, it will suffice here to mention the emergence and exploitation of fire, the complex modes of raw material acquisition and its transportation, the hunting and processing domain and the development of hunting weapons, the emergence of species-specific targeting as a mode of game exploitation, and the presence, albeit rare, of non-utilitarian objects.

Of great interest due to its high archaeological visibility is the realm of stone tool production. It is in this domain that particular aspects of the technologies characterizing the Neanderthal era first emerged in the Lower Paleolithic. The roots of the Levallois method remain to be thoroughly investigated but are documented prior to 250 Ka. The absence of this method from some of the sequences cannot be viewed simplistically (as is frequently done) as an indication for its appearance only in younger periods. It is in this field that integration of data derived from different and geographically distant sources should be carried out. Furthermore, there are preliminary indications for the development of the Levallois method in antiquity, identifiable by the exploitation of specific morphologies that are prerequisites for Levallois production. Particular traits required for lithic production by the Levallois method, such as selection of the raw material and foresight and meticulous planning (predetermination), were all common components of earlier stone-knapping traditions. In addition to particular methods (Levallois, Quina, etc.), other technologies, among which are the soft hammer technique and technologies of blade production, made their first appearance prior to the Middle Paleolithic. In fact, the soft hammer technique was applied to a relatively limited inventory during Mousterian times (Quina, MTA), but is well known from both the Levant and Europe during Acheulian times.

The processes involved in the colonization of the Old World are fundamental to the understanding of the behavior of the Neanderthals and their contemporaries. In particular, the ability to survive and to adapt in various regions and in different ecological niches provides some of the most attractive fields of investigation of the Neanderthal world. Examination of the geographical distribution of Middle Paleolithic cultural entities in Eurasia indicates an extremely widespread distribution over large territories – evidence of a “dispersal” of the Levallois method and associated lithic traditions in the Old World. This distribution is much more intensive than any of its typo-technological predecessors. The ways by which Neanderthals and contemporary populations related to the environments are partially understood due to repeated occupations of sites (mainly caves), and from their distribution in the landscape. The differences and similarities in tool kits and sites are hypothesized to result from mechanisms of territorial behavior, of functional behavior related to acquisition of raw material and to social structure, and behaviors that are assumed to reflect seasonal changes in the size of the paleo-community throughout the year. While function-specific sites existed during Lower Paleolithic times, the distribution of these earlier sites is much more limited. Nevertheless, they seem to reflect a large array of variability, most probably stemming from reasons similar to those cited in connection with the Neanderthals. These sites exist in various regions and ecological niches (from Western Europe to the Far East) but the diffusion, migration or colonization mechanisms that enabled hominins to expand into variable habitats and form recognizable sites in them are under continuous debate. Several issues are central to this debate: 1) How many colonization episodes (waves) took place before the Neanderthals and modern humans? 2) What were the main dispersal routes? 3) What was the material culture possessed by hominins at the time of any particular sortie?

Hominin behavior in a given region is entirely dependent on recognition and knowledge of the potential subsistence resources. Examination of the Levantine record indicates that the Acheulian occupied a remarkable diversity of landscapes. The distribution of sites clearly reflects the hominins’ comprehensive knowledge of the terrain of the Levantine Corridor. Sites are distributed throughout a variety of landforms, habitats and paleoclimatic zones. Central to this region is the close vicinity to freshwater resources, including regions that are currently arid. It is evident that dependence on water (ancient lakes, riverbeds and springs) necessitated a particular mode of behavior, and that the distribution of the sites in the proximity of these sources is indicative of a thorough knowledge of the landscape and its optimized exploitation. In-depth knowledge of the paleoenvironment in antiquity is expressed in the exploitation of raw materials. Patterns of acquisition and complex search for suitable raw materials already emerge from the earliest hominin African record, but become more sophisticated with time. Size, shape and properties dictate the search criteria and the transportation and mobility strategies involved. This mobility became more extensive and complex to supply suitable materials for particular products that were probably used to carry out pre-planned tasks. The identification of particular mobility patterns is extremely informative, as they suggest repeated movements within a given territory. The technological system involves an intricate network of acquisition, partial production, selection of particular items, transportation to focal points on the landscape, finalization of the shaping of the products, and frequently transportation of the final product to another (unknown) location. Although little is known of the functional aspects of the artifacts, patterns similar to those described above have been documented in Neanderthal behavior.

Recent discussion of the impressive hominin finds from Dmanisi have touched upon the question of whether they had the abilities to colonize the area or used it only ephemerally. Two geological formations in Israel furnish evidence indicative of the abilities of hominins to colonize territories in the Early Pleistocene and occupy them for a **very long duration**. While only a segment of each of these formations is exposed, both reveal repeated hominin occupations in lake-margin environments. The older ‘Ubeidiya Formation is of Lower Pleistocene age and is dated to ca. 1.4 Ma; the younger, the Benot Ya‘akov Formation (BYF), is dated to the Early and Middle Pleistocene and assigned to OIS 18-20. While each of the depositional sequences is located in a different segment of the Dead Sea Rift, **the estimated duration of each is in**

the order of 100 Ka. In both formations a very long sequence of occupations is revealed: the ‘Ubeidiya Formation yielded over 70 different sites, while at Gesher Benot Ya‘aqov over 13 sites were exposed.

Due to tectonic activity and erosion it is impossible to demonstrate that the Dead Sea Rift has been continuously occupied. However, a series of core drillings in the BYF has furnished geological and archaeological indications that the sequence is much longer than the segments that have been under recent investigation. Although both the top and the bottom of the BYF and the ‘Ubeidiya Formation are unknown entities, Why is the top unknown? it seems most likely that the Levantine Corridor was continuously occupied by hominins with different cultural traditions, each of which can be traced back to Africa. This pattern is crucial to the understanding of the processes of diffusion and colonization. The data illustrate the problematic nature of archaeological resolution, a difficulty that is pertinent to all archaeological periods but is of greater amplitude where Lower Paleolithic sites are concerned, due to the impact of natural processes affecting them over a much longer time span.

The Lower Paleolithic Levantine record, though segmented, indicates that predetermination, use of the Levallois method and systematic blade production existed long before the appearance of the Neanderthals. These findings underline the futility of the use of terminologies (such as the “Modes” system) that attempt to differentiate between the various sorties Out of Africa and identifiable entities of material culture. Anthropological studies should aim to re-examine and adjust the oversimplified modeling of early and modern hominin behavior.

As the cognitive abilities of the pre-Neanderthals are revealed through a wide array of multidisciplinary studies, the scope of our understanding of the Neanderthals is continuously growing. The current priority for the Pleistocene research community is to uncover the extent of the observable differences in abilities and behavioral patterns between Neanderthals and their ancestors, and to decipher the mystery of what lies hidden in them.

The Earliest European Peopling after the recent discoveries: early Neanderthals or different lineages?

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The exceptional 20th century discoveries of hominid remains in the north-west European hemisphere and the Southern Caucasus, considered, at least for now, as the earliest humanity settled in this part of the world, led some scholars to reappraise human evolution in those territories (see discussion in Mallegni, 2004). The humanity represented by the fossil record later than the above-mentioned finds is rather complex; the same can be said on the earliest specimens found in Africa; perhaps the calvaria found at Ceprano (Central Italy) and the remains found in Atapuerca (North Spain) should not be considered significant enough to suggest a contribution to the human lineages for the following reasons: the former is the only specimen showing a rather complex phenotipy which differs from the roughly contemporary fossil record (Mallegni et al., 2003); the latter consist of highly fragmentary bones mainly belonging to juvenile individuals (at least those used to create a new species).

We shall now consider the specimens found in Dmanissi, near Tiblisi (Georgia), mainly consisting of cranial remains dated 1.75 Ma (Gabounia, Vekua, 1995a-b; Gabounia et al., 2000; 2002). These finds are regarded, so far, as one of the proofs for the earliest hominids out of Africa. However, we should point out that the Caucasus is not necessarily part of Europe by a geographical viewpoint due to the mountain chain morphology; this divides the northern territories from the southern ones; furthermore, it is located in between two seas (Black and Caspian), and might have been an insurmountable barrier to accessing the Sarmatic Plain). From there the conquest of other European territories would have resulted less problematic, although we should not forget the possibility that climatic or geographic issues might have occurred.

Anyway, similar circumstances related to the human peopling of Europe seem to take place two other times: these are the settlement of the first hominids (those from Ceprano and Gran Dolina) at least 1 Ma earlier than those of Dmanissi, and the arrival of the early *sapiens* in the Near East (those defined “protocromagnoid” by Vandermeersch (1981) at about 0.4 Ka).

Were these culturally advanced early *sapiens* limited by climatic and/or bio-geographical factors?

It has been suggested that the earliest Pleistocenic humanity represented by the Dmanissi fossils might have had a future towards East; at least this is what we should expect when considering the humans who left their African cradle and appeared in the Far East (China; Java) between 1.8 and 1.6 Ma.

For these reasons we shall, at least for now, evaluate exclusively the fossils from Ceprano and Gran Dolina.

It is in the public domain that the Ceprano calvaria was found by accident in 1994, during construction works, and was dated 900/800 Ka relying upon the geological context of recovery; The specimen was probably provided of the upper facial bones, which must have been damaged by the inadequacy of its recovery. I. Biddittu was able to recognise fragments of a cranial vault: this was carefully reconstructed by F. Mallegni at the *Istituto Italiano di Paleontologia Umana* in Rome; this allowed to carry out both a metric and morphologic study (Ascenzi, Segre, 1997; Mallegni, 2004).

Ceprano's right portion is well preserved and was used to reconstruct the missing areas specularly through the use of a dioptograph. The left part is deformed *ab antiquo*, perhaps due to soil pressure.

The skull was measured according to the methods devised by Martin & Saller (1956-59) and Wood (1991). Thirty characters considered by Wood (1991) as typical of *Homo erectus* were also recorded when possible. This operation was also performed on further African hominid specimens earlier (*H. habilis, ergaster*) and later (*rhodesiensis*) than Ceprano, the Asian *H. erectus*, the European *H. heidelbergensis* and the early Neanderthals. It was decided not to include the Spanish *H. antecessor* (Bermudez de Castro et al., 1997) as it was created relying upon a juvenile mandible. The characters were used for a cladistic analysis, a methodology created by W. Hennig in 1966, which codifies character states to investigate phylogenetic relationships among taxa. This analysis has provided eight equally parsimonious trees, synthesised in a strict consensus tree. Such a cladogram indicates that the Asian specimens of *H. erectus* (Zhoukhoudian and Sangiran) cluster into a sub-clade. Asian *H. erectus* would be sister to a sub-clade including all the European and African human forms later that 1 Ma. This clade is, in its turn, formed by two sister groups: the former includes the specimens from Atapuerca and Steinheim, while the latter includes Ceprano, Arago, Petralona, Kabwe, Saldanha and Bodo (Mallegni et al., 2003). In comparison, the specimens found in Dmanissi seem to be closer to the root of this clade (OH-9) (Mallegni et al., 2003*)*.

The bootstrap values used as a statistical support to the analysis show that the clade including Ceprano, Arago, Petralona, Kabwe, Saldanha, Bodo, Steinheim and the findings from Atapuerca SH is clearly separated by Asian *H. erectus*, the finds from Dmanissi and OH-9.

Relying upon such results, a new species was proposed, as Ceprano shows characters which are absent in the earlier species, but do appear on the later African and European fossils.

Nothing to do with the Asian *H. erectus* fossil record.

Further studies dealing with each single cranial bone revealed different features from those observed on the few adult remains found in Gran Dolina (e.g. the temporal bone; cfr. Fabbri and Mallegni, 2005); this does not rule out the possibility that future findings at Atapuerca will show characters shared with Ceprano.

However, it is interesting to note that the Italian specimen shares some characters with the record defined as European *H. heidelbergensis*, namely Petralona and Arago XII and XLVII (especially on the frontal bone, but also on the occipital, such as those on Petralona) and African *H. heidelbergenis* (rhodesiensis) (Kabwe, Bodo, Saldanha; cfr. Mallegni et al., 2003; Fabbri, forthcoming).

This might suggest that Ceprano is an early relative both of the European and the African specimens (Mallegni et al., 2003).

As we know, the species *heidelbergensis* was created considering the traits observed on the Mauer mandible (Schoetensack, 1908); such a nomenclature was also extended to the above mentioned European specimens; we should point out, nevertheless, that the habit of creating species relying upon mandibular features was not lost, despite the availability of cranial bones: the holotype of *H. antecessor* is a juvenile mandible (although facial and cranial bones were found), and so is that of *H. georgicus* (in this case at least three skulls were found).

An excellent study by P.F. Fabbri (in press) dealing with Pleistocene mandibles demonstrated that this bone is not a reliable indicator of a species, as it does not show single and significant traits. For instance, we should be aware that the mandible D2600 shows two characters (large dimensions and prominence of the inferior-transverse torus) which are absent in the D211 mandible; however, both specimens were attributed to the species *H. georgicus*. Instead, these features can be observed on mandibles belonging to *H. erectus* from South-east Asia (e.g. Sangiran 6).

Furthermore, the holotypes of *H. antecessor* (mandibles ATD6-5 and ATD6-96) show distinctive features (small dimensions, small alveolar prominence, bowed mylohyoideus sulcus) observable on a number of mandibles of juvenile individuals of wide geographic, taxonomic and chronological diffusion. This does not rule out the possibility that the specimens found in Dmanissi and Atapuerca GD represent some unknown unidentified species of the genus *Homo*, but the criteria used to create these two species do not appear sufficient to us.

The Mauer mandible, perhaps dated to an early phase of the Middle Pleistocene, shows characters similar to those observed on the European fossils, commonly thought to be the direct ancestors of the Neanderthals: these could be considered as a "stem group" from which the later Upper Pleistocene humans evolved.

Such a model would be consistent with the "Accretion Model" proposed by Dean and co-workers (1998). According to the latter, Mauer may represent an "early-pre-Neanderthal", initial stage of this species' evolutionary history. On the same wavelength, Fabbri (in press) claims that considering Mauer as an early relative of *H. neanderthalensis* would not cause any bigger confusion than considering them as two different species on the same evolutionary lineage. After all, he notes, the concept that *H. heidelbergenis* may have an extra-European spread results weird when most of the specimens attributed to this species cannot be compared to the holotype.

The study by Dean et al. (1998) provides an excellent state of art on the evolution of hominids earlier than the classic Neanderthals. It illustrates the autapomorphies which appear slowly, and not all at the same time, as observable for the Upper Pleistocene classic Neanderthals. It is clear that these features do not appear all at the same time, nor are they entirely evident on the final stages of this species' evolution. A geographic factor occurs to us: the glaciations would have determined the existence of some isolated areas; in addition, the mountain chains would have created natural barriers preventing these human groups from getting in touch. This way, the Italian, Spanish, Balkan and North-European territories would have been a real "cul de sac" leading to the formation of characters, which spread in the genetic pool of these groups once they could interbreed again; this hypothesis could well explain the "mosaic" presence of these characters in quite contemporary specimens.

This interpretation supports the presence of Neanderthal apomorphy hints which, albeit not exclusive, are frequently observed on the European specimens from the Middle Pleistocene.

The same characters seem to lack in the late Lower Pleistocene hominids such as Ceprano and Atapuerca GD, while are definitely absent in the Dmanissi finds; these, due to their chronology and peripheral location, might not have played a role in the following peopling of Europe.

Furthermore, the presence of Neanderthal characters, approximately starting from 600-500 Ka, would be in agreement with paleogenetic data (Ingram et al., 2000) which propose a single chronology for the development of the Neanderthal lineage.

As a conclusion, we believe that the many plesiomorphic characters possessed by specimens such as Mauer, Atapuerca SH and Arago are not sufficient to imply the existence of different species or multiple evolutionary lineages, while the few characters which recall the "classical" morphologies of *H. neanderthalensis* are evidence of the phylogenetic continuity of European peopling from the Middle Pleistocene to the appearance of modern humans at the end of the Upper Pleistocene.

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Symposium 2: Neanderthal Palaeoenvironment

Conveners : WIGHART V. KOENIGSWALD & THOMAS LITT

Respondent: CLARK F. HOWELL

Dramatic climatic changes altered the environment of the Neanderthal population during the middle and upper Pleistocene. Although the general sequence of the climatic changes is known from the deep sea record, we are far from establishing a stable stratigraphy sequence for the terrestrial realm. The fauna and flora reacted very differently to the climatic changes in the various regions, which be discussed in a geographical framework. The regional conditions in central and western Europe will be compared with those in the Mediterranean.

Climate change and vegetation response in the Mediterranean during the Middle and Late Pleistocene

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An attempt is made here to place vegetation change in the Mediterranean area within the context of hierarchical scales of climate variability. These environmental regimes are (i) orbital-scale climate changes, generated by variations in the Earth's orbital geometry that affect the seasonal and latitudinal distribution of incoming solar radiation; and (ii) suborbital-scale changes, representing abrupt climate changes lasting centuries to millennia, whose origin is still debated but whose effects are becoming increasingly better documented.

Orbital scale (10^{4-5} yr)

Periodic variations in the Earth's orbital parameters (eccentricity: ~400- and 100-kyr periods; obliquity: 41-kyr; precession: 23- and 19-kyr) are the main forcing agent of the climate changes at this scale. While the Quaternary glacial-interglacial cycles represent an extreme expression of orbitally-driven climate change, the effects of orbital variability are pervasive throughout the Cenozoic. Obliquity is the primary beat of the glaciated part of the Cenozoic, underlining the sensitivity of ice sheets to high-latitude insolation changes associated with changes in the Earth's tilt (e.g. Zachos *et al.*, 2001). The Pliocene initiation of major Northern Hemisphere (NH) glaciation (Shackleton *et al.*, 1984) marks the onset of 41-kyr glacial cycles, while in the Middle and Late Pleistocene ice volume variations become dominated by the 100-kyr cycle along with a precession component (Imbrie *et al.*, 1984).

In the Mediterranean, obliquity-related variations in planktonic $\delta^{18}O$ records are recorded intermittently over the past 5.3 Ma and reflect changes in global ice volume, but the signal is amplified by changes in regional salinity and/or temperature (Lourens and Hilgen, 1997). In addition, planktonic $\delta^{18}O$ and SST records from the Mediterranean are strongly influenced by precession over at least the last 12 million years (Turco *et al.*, 2001). The Mediterranean precessional component is linked to lithology of marine cores, with $\delta^{18}O$ minima coinciding with sapropel layers and reflecting increases in freshwater input (e.g. Lourens *et al.*, 1992). This input is associated with periods of intensification of the African summer monsoon during precession minima (insolation maxima), leading to reduced deep-water ventilation in the Mediterranean. The freshwater input into the Mediterranean associated with sapropel formation has been traditionally attributed to increased Nile discharge (e.g. Rossignol-Strick *et al.*, 1982), but recent studies have suggested that northward penetration of the African monsoon beyond the central Saharan watershed at 21°N led to parallel discharge along the wider North African margin (Rohling *et al.*, 2002). The expansion of savanna-type vegetation over the Sahara during precession minima would also lead to increased cohesiveness of soil particles and reduced dust export to the Mediterranean (Middleton, 1987). Conversely, during precession maxima increased aridity and reduced vegetation cover in North Africa would provide increased dust supply to the Mediterranean.

Glacial-interglacial cycles

From the onset of major NH glaciation ~2.8 Ma to about 0.92 Ma, maximum ice volumes ranged between one-half and two thirds of the Last Glacial Maximum (LGM) value. The first extensive glaciation is recorded during Marine Isotope Stage (MIS) 22, ~ 0.9 Ma (Shackleton et al., 1990). Between 0.92 and 0.64 Ma (the so-called 'Mid-Pleistocene Transition'), the climate system shifted to higher amplitude, lower-frequency variability characterized by the intensification of glaciation and a prolongation of the glacial-interglacial cycle. From 0.64 Ma onwards the 100-kyr glacial cycle became established, with most pronounced glaciations occurring during MIS 16, 12, 6 and 2 (Shackleton, 1987). Recent results from the EPICA Dome C (EDC) record in Antarctica have focused attention on the extent of interglacial warming during the course of the Middle Pleistocene (EPICA Members 2004). More specifically, a prominent feature of the EDC deuterium (D) record is the so-called Mid-Brunhes Event (MBE) at the MIS 11/12 transition c. 430 ka, which marks the onset of greater amplitude glacial-interglacial variability, with pre-MBE interglacial maxima appearing significantly cooler than post-MBE maxima in Antarctica. A similar pattern is beginning to emerge from recent measurements of atmospheric greenhouse gases on air bubbles trapped in the EDC ice sequence, which show that CO_2 maxima during MIS 13 and 15 did not exceed 260 ppmv (Siegenthaler et al., 2005). This difference in amplitude between pre- and post MBE interglacials is, to a certain extent, also mirrored in marine benthic isotope records, although it is not clear whether this reflects increased residual ice volume during pre-MBE interglacials, or higher deep-water temperatures, or a combination of both.

With respect to the terrestrial record, favourable geological conditions in southern Europe have in some cases led to the relatively undisturbed accumulation of thick Quaternary sedimentary sequences. Such sequences provide an opportunity to develop complete records of terrestrial events over multiple glacial-interglacial cycles. The linking of the longest pollen sequences from southern Europe has led to the emergence of a coherent stratigraphical framework of changes in vegetation for the last 450 kyr and has allowed comparisons with the marine isotopic record (e.g. Tzedakis *et al.*, 1997; 2001), with one sequence, Tenaghi Philippon, NE Greece, extending continuously as far back as 1.35 Ma (Tzedakis *et al.*, in press). This showed that the many stages and substages into which the marine isotopic sequence is divided into are also appropriate for viewing the continental record, although the marine and terrestrial boundaries may not be precisely synchronous. These sequences show that during the past 1.35 Myr, Mediterranean vegetation has oscillated between two extreme situations: discontinuous herbaceous communities during glacials and interglacial forest/woodland. Between these two states, transitional phases occurred of varying duration and extent, depending on the direction and rate of change of the system and geographical location. With particular reference to the lower amplitude of interglacials preceding the MBE at 430 ka, the Tenaghi Philippon record, does not appear to show any significant difference in the extent of tree population expansions of the various forest stages. This is also reflected in the pollen record from Vallo di Diano, southern Apennines, Italy (Russo Ermolli and Cheddadi, 1997). It would appear that, at least in southern European sites with adequate moisture availability, differences in atmospheric CO_2 concentration on the order of 30-40 ppmv during interglacials have limited effect on the extent of forest development. However, this may not necessarily hold for areas where moisture availability is limiting and tree populations are near their tolerance threshold, because decreases in atmospheric CO_2 concentration can exacerbate water stress by reducing the water-use efficiency of vegetation.

Glacials

Biome distributions in southern Europe and Africa have been reconstructed for the LGM (Elenga *et al.*, 2000). The dominant vegetation was reconstructed as steppe (grassland or shrubland), with varying proportions of *Artemisia*, Gramineae and chenopods. With regard to the whereabouts of the arboreal component of vegetation during glacials, the prevailing hypothesis has been that remnant tree populations found refuge in the southern peninsulas of Europe where they survived in suitable microhabitats in mid-altitude zones and in locally moist sites in lowland and coastal areas. A record that has been closely linked to a classic refugial site in the Mediterranean is that from the Ioannina basin, situated in a topographically diverse landscape on the western flank of the Pindus mountain range, Greece. Two long pollen sequences spanning multiple glacial-interglacial cycles have provided evidence for the continued presence of temperate trees during the glacial periods, while the more thermophilous taxa show intermittent presence (Tzedakis, 1993; Tzedakis *et al.*, 2002). The persistence of tree populations at Ioannina during the last climate cycle is seen as a function of continued moisture availability from the nearby Ionian Sea, counteracting the effects of increased aridity and reduced CO_2 concentrations. An additional factor is the degree of topographical variability, which determines the extent to which populations can shift altitudinally in response to climate change. The synergy of these local factors appears to have buffered the most extreme effects of Quaternary climate variability, allowing the persistence of tree populations.

The absence of mediterranean sclerophylls during the LGM from sites like Ioannina suggests that in addition to the moist mid-altitude refugial sites, another type of refugium was also present located in low-altitude (valley bottoms and coastal plains), which were warmer but also drier. However, direct palaeobotanical evidence for such refugia is not in great abundance (but see the site of San Rafael in southernmost Spain [Pantaléon-Cano *et al.*, 2003]). Eustatic sea-level rise would have drowned the coastal plains that were exposed during the LGM lowstand in parts of the Mediterranean and with them the evidence of refugial stands. In addition, the distribution of trees at low-altitude sites may have resembled a savanna, with scattered low-density populations. This would be represented in pollen diagrams as low (background) percentages, which are difficult to interpret and often dismissed as 'long-distance transport'.

With respect to the latitudinal distribution of species in refugial sites, the following generalizations can be made. Populations of *Pinus*, *Picea*, *Larix*, *Betula*, *Salix* and *Juniperus* were present in the northernmost part of the southern European peninsulas and indeed further north during the LGM. With the possible exception of *Alnus* and *Corylus*, the LGM northern edge of most *temperate* trees would have been south of 46°N, probably even further to the south within hinterlands away from coastal areas. Populations of mediterranean species (*Olea*, *Pistacia*, *Phillyrea*, evergreen *Quercus*), whose distributions are limited by minimum temperatures, would have been further to the south.

Interglacials

At southern European sites with sufficient moisture availability, the interglacial succession is generally characterized by deciduous *Quercus*, mediterranean sclerophylls, *Corylus* and *Ulmus* expanding early, followed by *Carpinus*, *Ostrya* and *Tilia* and then *Abies* and *Fagus*. In contrast to these diverse interglacial successions, sites from southernmost Europe and from generally drier locations record Holocene vegetational developments that are mostly dominated by deciduous and evergreen *Quercus*, other mediterranean sclerophylls, and by *Pinus* and *Juniperus*. Moving to the Near East, a striking feature is that the expansion of woodland does not occur at the Pleistocene/Holocene transition of 11.5 ka, but is often delayed until about 8 ka (Wick *et al*., 2003). This may be a function of the increased and extended aridity during the boreal summer insolation maximum, the degree of the delay depending on local conditions keeping moisture availability below the tolerance threshold for tree growth. Another feature that emerges from many sites across southernmost Europe and the Near East is that AP maxima do not exceed 50-60%, suggesting that closed forest conditions were never established in these areas during the Holocene.

On the North African coast, pollen records from marine cores in the Nile cone area show large expansions of *Quercus*, *Olea*, *Pistacia* and other mediterranean taxa coeval with the deposition of the Last Interglacial and Holocene sapropels (Cheddadi and Rossignol-Strick, 1995). Further to the west, in the Kroumirie Mountains of Tunisia, the early Holocene is characterized by diverse communities, but after 6-5 ka a distinct increase in herbs is recorded (Ben Tiba and Reille, 1982). Equatorwards from the North African coast, early Holocene lake sediments from the Sahara have provided evidence of increased moisture availability over the interval 10-6 ka and palynological results show that savanna and desert grassland extended over regions that today are occupied by hyperarid deserts. Indeed, palaeobotanical data suggest that the Sahara/Sahel boundary had migrated northwards at least as far as 23°N and that the Sahara was drastically reduced, under the influence of the strengthened African monsoon (Jolly *et al.*, 1998).

Evidence from earlier interglacials is available mainly from southern Europe. This shows that over the last 430 kyr, the character of the vegetation succession was generally similar between interglacials, with a pool of taxa always expanding early, while others expanded in later phases. Early Middle and Early Pleistocene interglacials again show a sequential expansion of taxa but with the increasing presence of the so-called 'Tertiary relicts' as one moves back through time. For example, *Eucommia* tends to slot in the early part of the succession, with *Carya*, *Pterocarya* and *Tsuga* at increasingly later phases.

Suborbital scale (10^{2-3} yr)

An important development in our understanding of Quaternary environments has been the realization of the pervasive and extreme nature of millennial- and centennial-scale climate variability, especially during intervals of increased ice volume. High-amplitude air-temperature decreases have been recognized in the ice core records in Greenland (Greenland stadials or GS) and shown to be coeval with iceberg discharges and SST reductions (the most extreme of which are known as Heinrich Events [HEs]) in the North Atlantic throughout the past 110 kyr (e.g. Dansgaard *et al.*, 1993; Bond *et al.*, 1993) and indeed during earlier glacials (e.g. McManus *et al.*, 1999). These changes are associated with disruptions of the meridional overturning circulation (MOC), with North Atlantic Deep Water (NADW) formation shifting from the Nordic Seas to the subpolar North Atlantic during stadials, while during HEs, NADW was interrupted and the MOC was nearly, or completely eliminated (e.g. McManus *et al.*, 2004). These events were followed by a rapid resumption of the MOC and abrupt (within decades) warming on the order of 5-10°C, signalling the establishment of interstadial (GIS) conditions, sometimes lasting several millennia, before another rapid drop to stadial conditions.

The extension of North Atlantic climate variability to the Mediterranean region has been associated with polar vortex expansion during HEs and GSs, leading to cooling and aridity by outbreaks of polar or continental air (e.g. Sánchez Goñi *et al.*, 2002; Rohling *et al.*, 2003). In addition, the higher atmospheric pressure gradient in the North Atlantic during these cold intervals led to more vigorous Saharan winds and an increased meridional dust transport to the Mediterranean (Moreno *et al.*, 2005). The entrance of polar water through the Strait of Gibraltar during HEs contributed to the most extreme SST declines of the last glacial in the Western Mediterranean (Cacho *et al.*, 1999). These changes would be propagated eastwards, as reductions in SSTs would lower evaporation and therefore the moisture content of low-pressure systems moving across the Mediterranean, thus further intensifying the aridity. Indeed speleothem records from Israel provide clear evidence of cold and arid events associated with HEs (Bar-Matthews *et al.*, 1999). Interstadials (GIS) were characterized by higher sea surface and air temperatures and increased moisture availability (Cacho *et al.*, 1999; Sánchez Goñi *et al.*, 2002; Moreno *et al.*, 2005).

High-frequency oscillations in tree populations have been known for some time in pollen sequences from southern Europe (e.g. Follieri *et al.*, 1998), but despite the emergence of records supported by superior chronologies (e.g. Allen *et al.*, 1999), dating uncertainties were still too large to establish the exact phase relationship with North Atlantic climate variability. Joint pollen and palaeoceanographic analyses in the same marine sequence have provided a solution to this problem by allowing *in situ* comparisons between pollen and proxy indicators of ocean environment. Of particular significance are results from deep ocean cores in the Alboran Sea, Western Mediterranean. These sequences have furnished the first unequivocal evidence of the immediate response (within the sampling resolution of ~200 years) of vegetation to suborbital-scale climate variability (Sánchez-Goñi *et al.*, 2002; Combourieu Nebout *et al.*, 2002). Moreover, the records show a distinct separation in the magnitude of tree-population changes between HEs and intervening GSs, closely following the structure of SST changes in the same sequence. A similar pattern of large tree-population crashes during HEs and intermediate contractions during GSs can also be discerned in the pollen records from Italy and Greece (Allen *et al.*, 1999; Tzedakis *et al.*, 2004).

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Climatostratigraphy and paleoecology of the Middle and Upper Pleistocene in north-central Europe based on paleobotanical data

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Introduction

The division of Quaternary sequences on the basis of climatic changes documented in sediment records is fundamental and has a long tradition. Classifications based on climatostratigraphic units such as “glacials” or “interglacials” are reasonably well-established in north-central Europe and are accepted as regional standards (Gibbard and van Kolfschoten 2004; Litt et al. 2005).

The climatostratigraphic terms “interglacial” and “interstadial” were first defined by Jessen and Milthers (1928) for periods with characteristic records of non-glacial climate, as indicated by palaeobotanical evidence for major vegetation changes. Following these suggestions, interglacials in north-central Europe have been identified unequivocally as temperate periods with a climate optimum at least as the present interglacial (Holocene) in the same region. Interstadials have been described as periods that were either too short or too cold to reach the climate level of interglacial type in the same region. In numerous cases cold rather than glacial climates have tended to characterize the periods intervening between interglacial events. Therefore, the term “cold stage” has been adopted instead of “glacial” or “glaciation” (Gibbard and West 2000).

Middle Pleistocene

Cromerian Complex Stage

The “Cromerian Complex” Stage of the Netherlands, that mainly corresponds to the early Middle Pleistocene, is defined by the recognition of at least four warm temperate and three cold substages (Zagwijn 1985) indicating the climatic complexity of this time interval. The Early-Middle Pleistocene boundary should be linked to the Brunhes-Matuyama palaeomagnetic boundary which has been recognized as falling within Interglacial I (Waardenburg) of the Cromerian Complex or a bit later (780 ka, Marine Isotope Stage 19; see Turner 1996). The upper boundary of the Cromerian Complex is placed where major climate cooling heralds the onset of the Elsterial glacial Stage. In northern Germany, the warm stages of the lower Middle Pleistocene were palynostratigraphically defined based on a long continental record at Gorleben, Lower Saxony (Müller 1992). The Gorleben sequence encompasses five warm phases in a stratigraphic superposition above the Bavelian Stage and below the Elsterian Stage. The last Cromerian warm phase is the Rhume interglacial (Bilshausen interglacial) which correlates well with the corresponding part of the Kärlich interglacial of the Middle Rhine area (Bittmann and Müller 1996). The $^{40}Ar/^{39}Ar$ age of about 400,000 years allows a correlation of the Kärlich interglacial with Marine Isotope Stage (MIS) 11.

Elsterian Stage

The oldest glaciation represented by widespread till sheets throughout north-central Europe is the Elsterian glaciation. The term Elsterian, named after the river Elster in central Germany, first appeared on the geological maps (1:25,000) of the “Königlich Preußische Geologische Landesanstalt” (i.e. Keilhack 1911).

The Elsterian was the most extensive of all the glaciation in the central German type region. During two ice advances of the Elsterian Stage major erosional structures were formed which partly connected with the deeply incised valleys beneath the North German Lowlands (subglacial channels and basins). They were gradually filled with glacial, glaciolacustrine and fluvial sediments. In the erosional basins, lakes persisted through into the Holsteinian Stage.

Holsteinian Stage

The term Holsteinian originates from Geikie (1894), who described interglacial marine sediments as „Holsteinian beds”. Hallik (1960) first defined Holsteinian sediments palynostratigraphically and correlated them with continental-limnic interglacial records. Type sections of the Holsteinian are

Hamburg-Dockenhuden (marine deposits) and Bossel, west of Hamburg (lacustrine deposits) (see Jerz and Linke, 1987).

The INQUA Subcommission on European Quaternary Stratigraphy defined the lower boundary of the Holsteinian as the transition from subarctic (still late Elsterian) to boreal conditions, and the upper boundary as the transition from boreal to subarctic (Saalian) conditions (Jerz and Linke 1987). The interglacial vegetation development reconstructed by palynological data is very similar throughout north-central Europe and begins with a pine-birch forest. The immigration of thermophilous trees including alder, oak, elm, lime, esh, yew, and hazel occurred more or less simultaneously. The early expansion of spruce is remarkable. Hornbeam and fir immigrated during the course of the interglacial. Particulary characteristic of the Holsteinian Stage in north-central Europe is the appearance of *Pterocarya* and *Azolla filiculuides.* The first half of the Holsteinian is characterised by temperatures somewhat lower than today. In the second half, the reconstructed mean temperatures are higher than today, in particular the July temperature (Kühl and Litt 2006). In addition, the Holsteinian seems to be less stable than the present interglacial (Holocene) or the last interglacial (Eemian) with some intra-interglacial coolings. The magnitude of the main cooling in the Mid-Holsteinian is reconstructed as approx. 5°C for January temperature. No great change is reconstructed for July temperature during this episode.

The duration of the Holsteinian is estimated as about 15-16,000 years, based on varve counts of Müller (1974a) at Munster-Breloh. New Th/U datings based on peat deposits from the type section Bossel indicate an age of about 310-330 ka BP (Geyh and Müller 2005), which would correspond to MIS 9. This correlation contradicts to previous assumptions that the Hosteinian should be synchronized with MIS 11.

Saalian Complex Stage

Based on the definition of the Subcommission on European Quaternary Stratigraphy (Litt and Turner 1993), the Saalian Complex Stage encompasses the period from the end of the Holstein Interglacial Stage (boundary between boreal and subarctic phase of the subsequent Fuhne cold phase) to the beginning of the Eemian Interglacial Stage (beginning of the birch zone). After these specifications the Saalian proves to be a complex unit including several cold and warm fluctuations, whereas the latter may even reach the character of an interglacial.

The Lower Saalian Complex Stage, i.e. the period between the end of the Holsteinian Stage and the first Saalian ice advance, is characterised by extensive valley-widening and intense accumulation of fluvial gravels. There is some evidence in north-central Europe of at least one pronounced warm event (Dömnitz warm Stage in north-eastern Germany after Erd 1965 and as a synonym Wacken warm Stage in north-western Germany after Menke 1968) possibly even of two warm periods after Urban (1995). However, these warm phases are not separated by glacial sediments and chronostratigraphically they are situated before the first Saalian ice advance.

In northern Germany, the subdivision into two major ice advances has been used since Woldstedt (1954). The older Saalian ice advance (so-called Drenthe) marks the maximum extent of the Saalian ice sheet whereas the younger Saalian ice advance is named Warthe Substage.

Upper Pleistocene

Eemian Stage

The term Eemian was proposed by Harting (1874), who called certain sediments from a warm period after a small creek near Amersfoort (Netherlands). The type section (Amersfoort basin) has been palynostratigraphically defined by Zagwijn (1961). Recently, a borehole at Amsterdam Airport Terminal has been suggested as a new parastratotype, because it is more complete (van Leeuwen et al., 2000). The U/Th-age of the upper part of these interglacial deposits is 118.2±6.3 ka BP (van Leeuwen et al., 2000).

In north-central Europe, the Eemian Stage is by far the best-studied interglacial, whose sediments are located immediately above the glacial deposits of the Saale stage (in glacial basins both above Drenthe till and above Warthe till). Within the type area (Amersfoort basin in the Netherlands, but also in the Amsterdam basin as parastratotype) the classical Eemian sequences overlie the deposits of the Drenthe ice advance. Numerous long continental pollen sequences south of the Warthe line prove the existence of only one interglacial - the Eemian Interglacial - between the first Saalian ice advance (Drenthe) and the early Weichselian with its two boreal interstadials. The main characteristics of the vegetational succession are visible in most parts of Europe (Menke and Tynni, 1984). The initial interglacial forest development is characterized by birch woodland, followed by pine and mixed oak woodland. Subsequently, a widespread colonisation of hazel occurred. The interglacial climate optimum was reached in the early Eemian hazel-yew-lime zone and in the hornbeam zone with approximately 2°C higher average summer and winter temperatures than today. A gradual climatic deterioration can be followed through the hornbeam-spruce-fir zone to the boreal pine phase. The temperature course of Eemian Stage was not interrupted by pronounced climate oscillations as indicated both by isotope studies and quantitative palaeoclimate reconstructions based on palaeobotanical data (Litt et al. 1996, Kühl and Litt 2003). Based on varve counting on Eemian lacustrine sediments at Bispingen/Niedersachsen, Müller (1974b) calculates a duration of the interglacial of approximately 11,000 years. There is a consensus concerning the correlation and synchronisation of the Eemian warm stage with the marine isotope stage 5e. The onset of this warm stage is approximately 126 ka, the termination around 115 ka before present.

Weichselian Stage

The term Weichselian was introduced by Keilhack (1899). The type region is the upper valley of the river Weichsel (Polish: Vistula) (Meyer 1981).

According to palynological data, the Weichselian cold Stage starts with the transition between boreal forest vegetation at the end of the Eemian warm Stage to subarctic tundra vegetation. The Early Weichselian and the Middle Weichselian are characterised by several changes of stadials and interstadials. Most probably, the onset of the main glaciations started at about 25 ka BP, though glaciers possibly already advanced between 70 and 50 ka into the area of the western Baltic See/eastern Denmark (Houmark-Nielsen 1994). In northern Germany, the maximum extent of the Weichselian glaciation reached up to the Brandenburg area about 20,000 years ago.

Final remarks

The chronostratigraphical subdivision of the Middle and Upper Pleistocene in north-central Europe is mainly based on the inter-fingering of glacial and periglacial deposits such as till beds and gravel terraces in the type regions of the Elsterian and Saalian. Furthermore, intercalated interglacial sediments are well documented in outcrops and open pits. In contrast to the Alpine region, the stratigraphic scheme of the north-central European Pleistocene is not based on morphostratigraphy. The correlation and synchronisation of Middle Pleistocene sequences between the north-central European lowland and the northern Alpine foreland is uncertain, so far. Furthermore, there is no direct connection between the central European terrestrial records and the Marine Isotope Stages. Caused by uncertainties of absolute datings older than the last interglacial, the correlation between continental and marine sequences is still under debate.

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Evolution of the mammalian Pleistocene faunas in the Mediterranean area

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Since the early years of the XIX century was clear in the mind of many naturalists (Blumenbach, Cuvier, Buckland etc.) that during the last geological period big changes were occurred in the composition of European vertebrate faunas and especially of mammals. By mid XIX century the notion of warm and cold faunas characterising the recent geological past (the Pleistocene of Lyell) of Western and Central Europe was firmly established. In the last decades of XIX and the beginning of XX century, a period closed with the monumental work of Penck & Brückner on the Alpine glaciations, the alternative occurrence of “warm” and “cold” faunas as a result of climate modifications, was accepted. In the Mediterranean region changes in the fossil assemblages testifying the events detected in France and Germany were less evident. However Pareto (1865) illustrated for the first time several changes in the composition of successive fossil assemblages of the Italian peninsula and proposed a biochronological scheme based on these modifications. From that time very many publications deepened our knowledge on the bioevents occurring during the Pleistocene and extended the area of investigations to the other European peninsulas of the Mediterranean and also to its eastern (Asiatic) and southern (African) borders. Correlations of continental fossil bearing deposits with marine sequences, radiometric data and magnetostratigraphic calibrations improved the accuracy of continental bioevents. Target of this paper is a qualitative description of the major modifications on the Pleistocene mammal associations in the Italian, Iberian and Southern Balkan peninsulas.

Italian Peninsula:

Azzaroli (1977) proposed the subdivision of the Italian mammalian assemblages of the Villafranchian Mammal Age (Middle Pliocene – Early Pleistocene) to a number of Faunal Units (F.U.). This biochronological scheme was extended later to Galerian and early Aurelian Mammal Ages (Middle Pleistocene) (Gliozzi *et al.*, 1997). During this time-span several mammal dispersal events have been detected (Azzaroli, 1983; Azzaroli *et al.*, 1988; Sala *et al.*, 1992; Torre *et al.*, 1992, 1999) and, based on these data, many papers dealing with the evolution of mammalian Pleistocene communities of Italy have been published in the last years (Sardella *et al.*, 1998, 2006; Torre *et al.*, 2001; Palombo *et al.*, 2000-02, 2005; Azanza *et al.*, 2003, 2004; Palombo, 2004; Palombo & Valli, 2004; Raia *et al.*, 2005, 2006; all with bibliography). A new approach, based on palaeocumunities concept (a single palaeocomunity is recognized as an ecological/evolutionary unit), has been recently proposed to integrate the classical biochronological framework (Raia et al., 2006). These publications are based on large mammal communities study because the small mammal fossil record is less well known, but some recent studies give a sufficient picture of the modifications of micromammal assemblages (Maul *et al.*, 1998; Kotsakis *et al.*, 2003).

Middle Pliocene (Early Villafranchian, Early Villányian) mammal assemblages of Italy are characterised by the predominance of typical forest elements, common in Europe, like *Ursus minimus*, *Zygolophodon borsoni*, *Tapirus arvernensis*, *Sus minor* and micromammals of large European distribution (*Mimomys hassiacus* etc.). At the beginning of Late Pliocene (Middle Villafranchian, Late Villányian) a very important and sharp modification occurs, result of a strong climatic modification. Many forest taxa disappear and an important dispersal event, the "Elephant-*Equus* event" took place. *Mammuthus (Archidiskodon) gromovi*, *Equus livenzovensis*, the cervid *Eucladoceros*, are among the immigrant taxa from Eastern Europe. Micromammals are characterized by elements of large European distribution but also by some taxa like *Dinaromys* and cf. *Ellobius*, taking the westernmost boundary of their distribution. A new turnover (less marked) event characterizes the time-span around the Pliocene–Pleistocene boundary (Late Villafranchian, Early Biharian): the "Wolf event". Several bovids (*Gazella*, *Gazellospira*, *Procamptoceras*, *Gallogoral*) and cervids (*Procapreolus*, *Croizetoceros*) disappear whilst carnivores like *Canis*, *Lycaon*, *Panthera*, the large hyaenid *Pachycrocuta brevirostris* and the bovid *Praeovibos* make their first appearance. During Late Villafranchian (Early Biharian) two other modifications in the composition of large mammal assemblages have been observed. They are characterized by the disappearance of *Eucladoceros* , the first occurrences of the cervid *Praemegaceros* and the bison of the subgenus *Bison (Eobison)* and also by the presence of African immigrants (*Hippopotamus*, *Theropithecus*, *Megantereon whitei* – first occurrence in Italy not isochronous). Among Early Biharian micromammals of Italy the more characteristic elements are several species of the arvicolid *Allophaiomys*. The Villafranchian/Galerian boundary is marked by the second sharp modification (Middle Pliocene/Late Pliocene being the first one) in the composition of the large mammal assemblages, the so called "end-Villafranchian event". We observe the disappearance of genera or subgenera established from long time in the Italian peninsula like *Acinonyx*, *Megantereon*, *Mammuthus (Archidiskodon)*, *Leptobos*, and the arrival of new elements: *Crocuta crocuta*, *Elephas antiquus*, *M. (Mammuthus) trogontherii*, *Equus ferus*, *Sus scrofa*, *Cervus elaphus*. *Neodon gregaloides*, the first *Microtus (Microtus)*, and oriental elements (*Prolagurus*, *Prediscrostonyx*), are present among small mammals of Late Biharian (= Early Galerian). Two other turnovers of the Galerian large mammal assemblages are pointed out: the first one characterized by the extinction of *Praemegaceros verticornis* and *Megaloceros savini* and the immigration of *Dama*, *Hemitragus*, *Bos*, the second one, less marked, characterized by the disappearance of *M. trogontherii* and *Hippopotamus antiquus* and the first occurrence of *Cuon alpinus*, *Hippopotamus amphibius* and *Bison priscus*. Among the small mammals of this period (earlier part of Early Toringian) we observe the appearance of *Arvicola cantianus* and the arrival in the north-eastern part of the peninsula of many new elements (*Citellus*, *Cricetus cricetus*, *Stenocranius gregalis*, *Chionomys nivalis*, *Ochotona*). The turnover at the boundary of Galerian/Aurelian is marked by the disappearance of *Ursus deningeri*, *Bison shoetensacki* and the last sabre-toothed tiger of the genus *Homotherium*, and the appearance of

Ursus spelaeus, *Equus hydruntinus*, *Megaloceros giganteus*, of the living species *Canis lupus*, *Dama dama*, *Capra ibex*, and of primitive members of the lineage of the woolly mammoth, *Mammuthus chosaricus–Mammuthus primigenius*. *Marmota marmota* and *Mirotus oeconomus* are present in North Eastern Italy. The changes in the faunal assemblages during late Middle Pleistocene and Late Pleistocene are limited in a small number of new immigrations (*Gulo gulo*, *Coelodonta antiquitatis*, *Alces alces* among large mammals), and a large number of extinctions (*Ursus spelaeus*, *E. antiquus*, *Stephanorhinus hemitoechus*, *S. kirchbergensis*) or local extinctions (*Panthera pardus*, *Panthera leo*, *H. amphibius*). Both immigrations and extinctions took place in different times. In the NE Italy many "cold" elements appear or reappear among small mammals (*Sicista*, *Microtus oeconomus*, *S. gregalis*, *Ochotona pusilla*) but were unable to colonize the Central and Southern Italy. During this time-span palaeobiodiversity was high in the Veneto region, as well (or slightly higher) in the central European one. On the opposite in Central and especially in Southern Italy, palaeobiodiversity is rather low. A general observation on the faunas of late Middle and Late Pleistocene concerns the differences between the two sides of the peninsula with very different percentages of presence of bovids, cervids and equids among large mammals, and the colonization of the Adriatic side by several species not present in the Tyrrhenian coast.

Several analyses of the data concerning the large mammals for the period Late Pliocene-middle Middle Pleistocene evidenced a strict correlation between climate changes and faunal turnovers. Italian peninsula during the cooling trend characterising the Pleistocene, acted as a temporal refuge for older species, born in warmer climatic conditions. Very few local speciations were recognized (as far as concern our knowledge, especially for rare species) in Italian peninsula. Four or five species of macromammals and ten species of micromammals (living species without fossil record included), have been recorded from Middle Pliocene to Holocene. It is interesting to observe that the lineage of the cervid *Axis (Pseudodama)* present in Italy with three species, and the rare (known only from the holotype) bovid *Hemibos galerianus* have been assigned to genera of the Oriental biogeographic region. Immigrations generally arrived from the north-eastern corner of the Peninsula, nevertheless, some micromammals (of different age) are common with the Iberoccitanic region only (*Mimomys medasensis*, *Allophaiomys chalinei*, *Iberomys brecciensis*).

Southern France

Many palaeontologists worked on Plio-Pleistocene mammals of France (Depéret, Boule, etc.) and some of them proposed subdivisions based on the fossil assemblages. In recent times Mein (1975) proposed a system of "biozones" to subdivide the European Neogene (cfr. also Mein, 1990, 1998 – MN 1 to MN 17). Guérin (1982) expanded this system to cover the Quaternary (MNQ 18 to MNQ 26, see also Guérin, 1990, Guérin & Patou-Mathis, 1996). Several theoretical differences exist between the Italian F.U. and the French MN and MNQ zones but correlations of the two systems are possible. The difficulties arose from differences between French and Italian fossil record. Abundant remains of Pliocene (Ruscinian and Early and Middle Villafranchian faunas) are followed by very few sites with Late Villafranchian faunas. The fossil record is again very good for Middle and Late Pleistocene (Palombo & Valli, 2003-04, 2004). Studies on turnovers, dispersals and immigrations of fossil mammals of France have been made recently by several authors (Bonifay, 1996; Alberdi *et al.*, 1997; Montuire & Desclaux, 1997; Azanza *et al.*, 2000; Palombo & Valli, 2003-04, 2004). French Late Pliocene and Pleistocene mammalian assemblages are similar to the Italian ones but are characterized by the presence of some peculiar elements lacking in Italy. Moreover several appearances and/or disappearances are diachronic. Some of the differences are reported in the following paragraph:

In Late Pliocene (after the "Elephant-*Equus* event") southern France is characterized by the presence of *Canis senezensis* and the cervid *Cervalces gallicus* whilst *Anancus* was extinct. The lemming (*Lemmus* sp.) make also its appearance. In the time-span around the Plio-Pleistocene boundary we observe the disappearance of the sabre-toothed tiger *Megantereon cultridens* and the bovids *Pliotragus*, *Gallogoral* and *Procamptoceras*. *Lynx issiodorensis* is replaced by *Lynx spelaea*. The large *P. brevirostris* makes its first appearance and coexists with *Pachycrocuta perrieri*, a fact not observed in Italy. A very marked dispersal event took place arround 1 Ma and corresponds to the "end-Villafranchian event" and the beginning of Galerian faunas. *M. (A.) meridionalis* is still present. During the temporal segment of Middle Pleistocene corresponding to Galerian, we observe at least three turnovers in the faunas (Palombo & Valli, 2003-04, 2004). Carnivores like the wolverine (*Gulo*) and the dhole (*Cuon*) make their appearance earlier than in Italy, as the wild European ass (*E. hydruntinus*) and the chamois (*Rupicapra*). The reindeer, *Rangifer tarandus*,is signalled in the Pyrenean area together with *Praeovibos priscus* and the collared lemming, *Dicrostonyx*. *Hemitragus*, a bovid very rare in Italy, is a common element of the assemblages. The turnover corresponding to the boundary Galerian/Aurelian is very similar to that observed in Italy, but the woolly rhinoceros (*C. antiquitatis*) is also present and the reindeer colonizes the Mediterranean border. During Late Pleistocene "warm-temperate" faunas alternates with "cold" faunas. Boreal elements like *M. primigenius*, *C. antiquitatis*, *R. tarandus*, *Dicrostonyx*, *S. gregalis* are present in the "cold" assemblages. *Saiga tatarica* colonizes the coastal plains of the Mediterranean and also the arctic fox, *Alopex lagopus*, makes its appearance. During the earliest part of Late Pleistocene the immigration of *Lynx lynx* is also observed.

In Southern France several "warm" mammals disappear earlier than in Italy (with a few exceptions), some "cold" taxa appear also earlier and some elements never reaching Italy, such as reindeer, saiga antelope, arctic fox , collared lemming, are members of the faunal assemblages.

Iberian Peninsula

The study of fossil vertebrates of Iberian peninsula was strongly increased during the last forty years. The Pleistocene mammalian faunas are now very well known. A biochronologic scale based on similar concepts of Mein's zones (MmQ zones 1-4 for Early and Middle Pleistocene) has been proposed by Agusti *et al.* (1986) and modified by Oms *et al.* (2000). Studies on turnovers, dispersals and immigrations of fossil mammals of Iberian peninsula have been made recently by several authors (Agustí & Moyà-Solà, 1992, 1998; Sesé , 1994; Sesé & Sevilla, 1996; Alberdi *et al.*, 1997; Azanza *et al.*, 1997, 2000, 2003; Cuenca-Bescós *et al.*, 1999 for Atapuerca). The succession of mammalian assemblages is similar to the Italian one but a great number of immigrations and extinctions occur in different times in the two peninsulas (diachronic events). The mammalian faunas of the Iberian peninsula are characterized by a slightly higher number of endemisms of large mammals than the Italian peninsula, but by a much higher number among small mammals.

The "Elephant-*Equus* event" is evidenced in the fossil record. Together with *Mammuthus* and *Equus* the bovid *Gallogoral* make its appearance (as in Southern France). The immigration of several carnivores (*Canis*, *Panthera*, *P. brevirostris*) characterizes the latest Pliocene and corresponds to the "Wolf event". The peculiarity of the first Pleistocene mammal assemblage (Late Villafranchian, Early Biharian) of the Iberian peninsula, marked by the immigration of the vole *Allophaiomys pliocaenicus*, is the coexistence of many Villafranchian species with elements like *Soergelia* and *Capra*. In Italy and/or in Southern France they appear more recently. Three taxa of African origin are also present (*Megantereon whitei*, *Theropithecus*, *Hippopotamus*). Among small mammals East/Central European taxa are signaled in a single site (*Ungaromys*, *Prolagurus*). In the next turnover (corresponding to the Villafranchian–Gallerian boundary), *E. antiquus*, *Cervus, Bison*, *Bos* and other large mammals make their appearance whilst many Villafranchian elements disappear. Another turnover (Early Galerian) is characterized by the appearance of *Crocuta*, *U. deningeri* and *Capreolus* Several micromammals (*S. gregaloides*, *Terricola arvalidens*, the endemic species *Iberomys huescarensis*, *Microtus seseae*, and also *Marmota*) are present. The first appearance of *M. trogontherii* and a few micromammals (*Arvicola cantianus* among them) marks the beginning of Toringian (corresponding to the central part of the Galerian), whilst the time-span corresponding to Late Galerian and Early Aurelian is characterised by the immigration of *Bison priscus* and some other taxa. In the recent part of the Late Pleistocene (Late Aurelian) temperate species, already present in the Iberian peninsula, dominate the assemblages but in the Pyrenees "cold" elements occur sporadically (*M. primigenius*, *C. antiquitatis*, *R. tarandus*, *S. tatarica*, *G. gulo* and the muskox *Ovibos moschatus*). *M. oeconomus*, *S. gregalis*, *Dicrostonyx*, *Citellus*, are boreal or eastern forms reaching the Iberian peninsula.

Greece

The Neogene and Quaternary record of fossil mammals in Greece is extremely rich. But the excellent material of the Miocene localities fascinated palaeontologists since the times of Gaudry. However, in the last two decades Pleistocene mammals was the object of several studies and a lot of papers have been published, including some general works (Tsoukala, 1992; Koufos & Kostopulos, 1997; Koufos, 2001). As the data of the fossil record in Balkan peninsula and Anatolia are not homogeneous, it is difficult to detect the endemic non-insular species of the southern part of the Balkan peninsula.

In Greece the earliest occurrence testifying the "Elephant-*Equus* event" is placed in the earliest part of Middle Villafranchian. The faunas associated with the newcomers are characterized by many first occurrences (*Croizetoceros*, *Eucladoceros*, *Gallogoral*, *Gazellospira*) and the presence of characteristic elements like the carnivore *Bosdagius felinus* and the giraffid *Mitilanotherium martinii*. *Anancus* and *M. (Archidiskodon)* are present together in the same association. The murid *Rhagapodemus* disappears during this time-span. Latest Pliocene (early Late Villafranchian, Late Villányian) is marked by the "Wolf event" and the immigration of carnivores (*Canis*, *Panthera*, *P. brevirostris*) and herbivores (*Parastrepsiceros*). *P. perrieri* is still present. Among small mammals the arvicolid *Jordanomys*, a Near Eastern element, make its appearance. In the Early Pleistocene faunal assemblages (Late Villafranchian, Early Biharian) we observe the disappearance of many cervids and bovids and the occurrence (similar to Italian peninsula) of *Hippopotamus*, *Praemegaceros*, *Allophaiomys* and *Mimomys savini*, appearing in different moments. A characteristic element is *Pontoceros*. The Asiatic gerbillid *Meriones tristrami* (associated to a member of the genus *Mus*) is known from an island (Kalymnos) near the Anatolian coast. The latest Villafranchian faunas include many new bovids (*Soergelia*, *Hemitragus*, *Ovis*), several canids, and the African species *M. whitei*. Elements of East European affinities are present among the micromammals (*Spermophilus nogaici, Pliospalax seni*). *C. mosbachensis*, and *U. deningeri* are the first species heralding the Galerian faunas, followed by *E. antiquus*, *C. crocuta* and other elements. Our knowledge on the Middle and Late Pleistocene faunas is more limited. The time-span corresponding to the boundary Galerian-Aurelian is the moment of the appearance of "cold" elements like *M. primigenius* and *C. antiquitatis*. They extend to the south their colonization to Peloponnesus.

Insular Faunas

The Mediterranean islands are characterized by peculiar faunal assemblages with "dwarf" large mammals and "giant" small mammals, low biodiversity and strong endemism. Each island is characterized by a proper colonization timing. In Sicily the beginning of Pleistocene is characterized by faunal assemblages with low biodiversity and high number of endemisms, meaning a long isolation time. On the opposite, since the later part of Middle Pleistocene, three Sicilian Faunal Complexes are characterized by rather low endemism and nearly "continental" biodiversity, that points out the continuous improvement of crossing conditions between the island and Italian mainland (Messina Strait area). Sardinia (and Corsica) is (are) characterized by an isolation phase during Middle Pliocene followed by a relatively high biodiversity period during Late Pliocene - Early Pleistocene and, finally, by an "oceanic" phase (low biodiversity, strong endemism, absence of new immigrants) during Middle and Late Pleistocene. Crete Pleistocene assemblages testify almost oceanic island conditions, with very low biodiversity, very marked endemism and few new immigrants. The colonization occurs by means of dispersal events (filtering bridges) or sweep-stake ways. Oceanic conditions are testified for Baleares (no Plio-Pleistocene mammalian immigrants at all) and Cyprus (Kotsakis, 1990; Alcover *et al.*, 2000; Bonfiglio *et al.*, 2002; Abbazzi *et al.*, 2004).

Conclusions:

1) The main dispersal events, if slightly diachronic, are observed in the three peninsulas. Some problems arise with the "end-Villafranchian event" in Iberian peninsula. 2) The composition of Pleistocene assemblages of the Mediterranean European peninsulas is the result of the combination of survival of Pliocene elements, of mammalian immigration and dispersal events from North-North East, limited immigrations from Africa, and a low number of speciation events. In addition, local dispersal events from a Mediterranean area to an other have been also observed. Near Eastern elements are present in the Southern Balkan peninsula. 3) The three peninsulas acted as refuge areas (role increasing from east to west) for "warm" assemblages during cool/cold phases of the Pleistocene.

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Climatic changes, faunal diversity, and environment of the Neanderthals in Central and Western Europe during the middle and upper Pleistocene

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The unusual geographic conditions in Central and Western Europe

Central and Western Europe was very pivotal in the elucidation of Pleistocene history. It was in this region, that the first traces of the great expansion of glaciers during the Pleistocene were recognized and, later, that the scheme of glacial and interglacial periods was deduced from the several generations of moraines and boulder clays. In no other part of the world did this very complex sequence of events become as apparent.

Similarly, the fossil occurrence of mammals that live today in the Arctic, such as *Rangifer, Gulo,* and lemmings (*Lemmus* and *Dicrostonyx*), was recognized in the fossil record. Koken (1912), for example, when describing the Pleistocene faunas of Paleolithic sites in Germany, differentiated between glacial faunas characterized by *Mammuthus primigenius* and interglacial faunas characterized by *Elephas antiquus.*

In Western and Central Europe, faunas and floras can often be more readily attributed to a glacial or interglacial environment than to a specific age, since very similar faunal and floral assemblages appeared in all the glacial or all the interglacial faunal periods, respectively. In the Pleistocene flora, the sequence of immigration of the various taxa is very characteristic, but the fossil record does not reflect these details in the fauna.

Such an obvious contrast between glacial and interglacial faunas is not known from North America or any other region of the world. It is the specifically the geography of Europe, especially the orientation of the mountain ranges, that is responsible this difference. The Pyrenees and the Alps are both oriented from west to east and thus formed an ecological barrier between Central Europe and the Mediterranean region. They also buffered minor climatic oscillations. Any influence from the Arctic was ameliorated in the Mediterranean region and minor climatic oscillations did not affect the glacial fauna in the north. Faunal turnovers occurred in Western and Central Europe only between glacial and interglacial periods. Glacials and interglacials differed not only in their mean annual temperatures, but even more so in their annual temperature fluctuation and the relative humidity. Glacial periods had a strong continental climate, while interglacials were characterized by a strong maritime influence. It was specifically the changes in humidity that catalyzed the drastic faunal exchange between the *Mammuthus* assemblages and the *Elephas* assemblages.

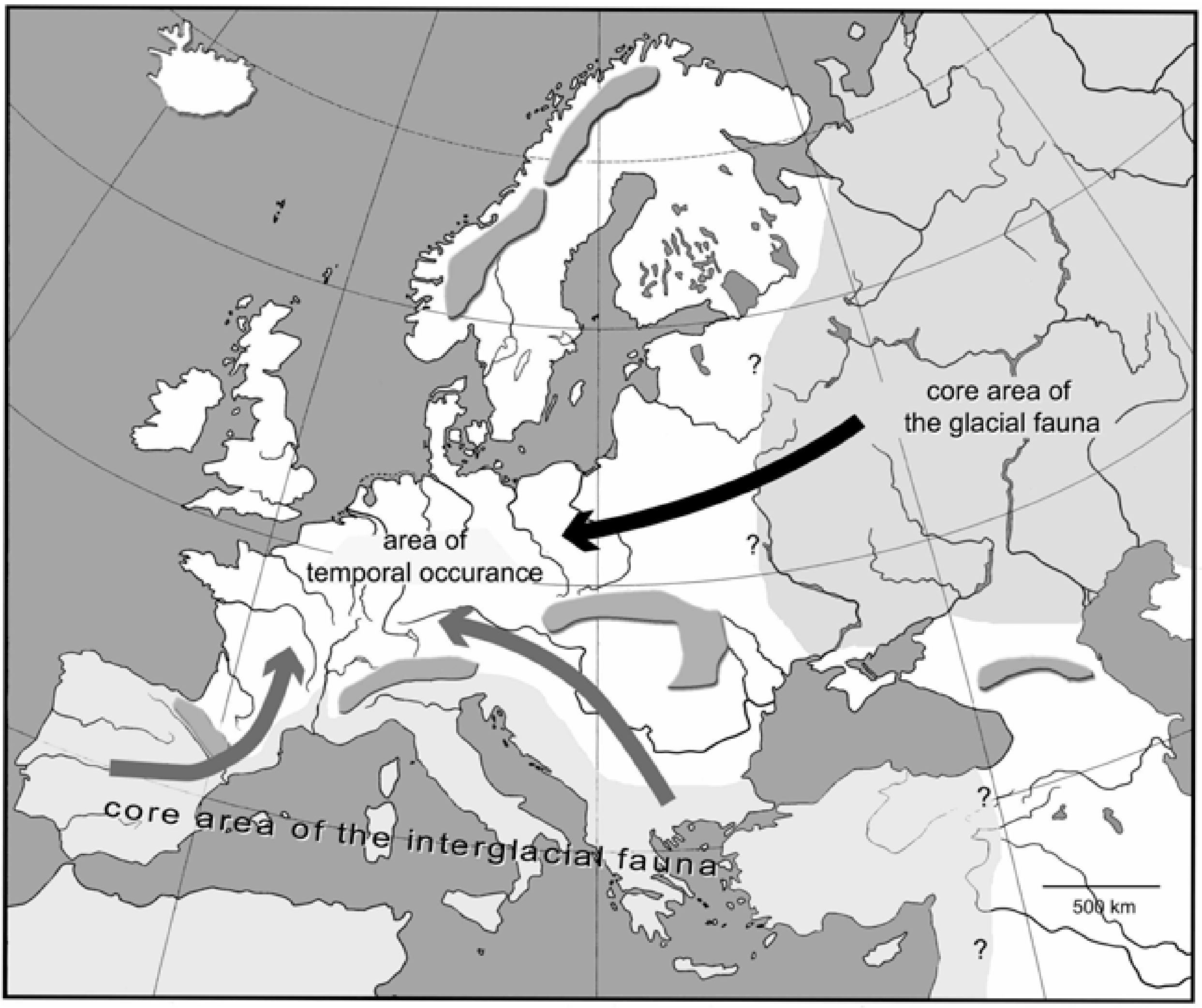
In contrast to the climatic shifts in Europe between continental to maritime conditions, Siberia has always maintained a very dry and continental climate. Thus, interglacial faunas in Siberia hardly differ from glacial assemblages in the same area. In North America, where the Rockies and Appalachians are oriented north south, the Great Plains between these two mountain ranges maintained a continental climate, too. Hence, it is not surprising, that the faunas of the glacial and interglacial periods in Siberia and North America did not change to the same extent as they did in Western or Central Europe.

Immigration and local extinction form the faunal exchange in Western and Central Europe

The *Mammuthus* assemblages characterizing the glacial periods in Western and Central Europe immigrated from the northeast. In contrast, the *Elephas* assemblages expanded their area from the Mediterranean regions using the major river valleys of the Rhine and the Danube as immigration routes. The faunal exchange was very intensive since only few herbivores occurred in both assemblages. Carnivores were generally not as much affected. After the onset of unfavorable climate conditions in Western and Central Europe species that could not tolerate the climate disappeared. The term "emigration" is often used for this process, deduced from the idea that clever humans knew how to escape an unfavorable situation. However, for the fauna, this disappearance should be more precisely called a "local extinction". The biological reaction to an unfavorable climate is a reduction in the number of offspring. If the unfavorable conditions last for several generations, this leads to extinction in a local area. In contrast, the emigration of entire populations would require empty species niches in regions that still had favorable environmental conditions.

Due to a repeating pattern of immigration and local extinction, Western and Central Europe was an area of "temporal occurrence" for most mammalian species (Koenigswald 2003). There are only a few mammalian genera that occur in both glacial and interglacial faunas, e.g. *Ursus*, *Cervus,* and *Arvicola*. Nevertheless even in these genera it cannot be excluded that re was some exchange of populations, since subspecies are generally not recognizable in the fossil record. It is important to realize for the evolution of taxa that were affected by the faunal exchange took place in areas where these species were continuously present. These areas are defined as the "core areas" from which the species immigrated. Only in the core areas was there any evolutionary continuity. Nevertheless, even in the regions of temporal occurrence these newly evolved forms may have reappeared each subsequent phase, but such cases are rare.

It remains open to what extent human populations were involved in the faunal exchange. In the early part of the middle Pleistocene humans, occurred only in Central Europe during interglacial periods only, and thus with each warming a new immigration is probable. Only during the (late?) Saalian Complex did Preneanderthals coexist in the biome with the *Mammuthus* assemblage in Central Europe. During the Eemian, humans hunted game in the *Elephas* assemblage, while during the Weichselian humans, this time in the form of the classical Neanderthals, lived alongside the *Mammuthus* assemblage once again. The fossil record shows the presence of man during this interval of glacial - interglacial - glacial conditions, but it is not detailed enough to indicate whether these populations remained in the areas north of the Alps or if the different populations immigrated into the region.



The main direction of faunal movements during the middle and upper Pleistocene

Biostratigraphy of the middle and late Pleistocene in Central Europe

The multiple faunal exchanges in Western and Central Europe are characterized by the repeated immigration of taxa. Thus it is difficult to do any stratigraphy using first and last occurrence dates (FAD, LAD) since the presence of the taxa was not continuous and because some taxa irregular in their reoccurrence. Compared to the Tertiary the time span of the middle and upper Pleistocene is too short for major evolutionary changes, and continuous evolution of certain forms can be expected only in the core areas.

The rodent genus of *Arvicola*, a vole, is one of the few taxa present in Western and Central Europe throughout the middle and upper Pleistocene, that shows evolutionary changes that can be used as stratigraphic markers (Koenigswald & Heinrich 1999). A biostratigraphic framework based on *Mimomys* and *Arvicola* voles is thus summarized here. One species in particular, *Mimomys savini,* characterizes the mammalian faunas at the beginning of the middle Pleistocene, which are found at Voigtstedt and Süssenborn in Thuringia and the Upper Freshwater Bed of the Cromer Forest Bed Series in East Anglia. In this way, the *Mimomys savini* faunas correlate with part of the Cromerian complex.

During the Cromerian, *Mimomys savini* was replaced by *Arvicola cantianus. Mimomys* differs in having rooted molars, while those of *Arvicola* are rootless. *Arvicola* most likely derived from *Mimomys*, however not in Central Europe, but in the south where it might have been present somewhat earlier. Stratigraphically, *Arvicola cantianus* occurs in Central Europe in the late Cromerian. Although *Arvicola* it first shows up with the interglacial *Elephas antiquus,* this vole remains in Central Europe even after the onset of cold climate conditions and after the *Mammuthus* fauna immigrated. These faunas, known as "early *Arvicola cantianus* faunas", are thought to have antedated the Elsterian. They show a greater diversity in insectivores and rodents than those after the Elsterian Typical sites with these early *Arvicola cantianus* faunas are Mauer, Mosbach, and Kärlich G.

After the Elsterian *Arvicola cantianus* remained an index fossil, but the diversity of other small mammals became reduced. These faunas, which range from the Elsterian to the Hosteinian and the Saalian complex, are defined as “late *Arvicola cantianus* faunas” and occur in both glacial and interglacial phases. Within this time period, a change in the enamel thickness in the molar teeth of *Arvicola,* so called SDQ, can be observed (Heinrich 1987). This evolutionary trend can be used to some degree as a stratigraphic indicator, although it is still possible to correlate these faunal levels with the OIS since the position of the Elsterian is still unclear. According to Sarntheim et al. (2001) and Parfitt et al. (2005), the Anglian (=Elsterian) represents OIS 12 and Schreve (2001) correlates the Hoxnian with OIS 11 based on the supposed sequence of terraces in England. However, the type locality of the Holsteinian, which should be the time equivalent of the Hoxnian, was dated recently and correlated with OIS 9 (Müller & Geyh 2005). The stratigraphic position of interglacials before or within the Saalian complex is problematic due to different interpretations of the geology in the Elbe-Saale region. Mania & Thomae (2006) postulate four interglacial phases in the Holstein Complex before the Drenthe (first Saalian ice advance) and two additional ones before the Warthe (second Saalian ice advance). Litt et al. (2005) accept one or at the most two interglacial phases after the Holsteinian and before the Drenthe, but none between Drenthe and Warthe. The *Elephas* assemblages at the relevant sites are nearly identical. It is possible that the occurrence of *Bos primigenius* in Steinheim/Murr and Schöningen indicates an age younger than Bilzingsleben II.

Faunas of the Eemian (OIS 5e) and the early Weichselian reflect a transition from *Arvicola cantianus* to *Arvicola terrestris*. *Arvicola terrestris* then continues from the Weichselian into the Holocene (OIS 1). The large mammals of the *Mammuthus* assemblage are thus very similar to those of the Saalian.

Ecology and biostratigraphy of German localities with human remains

Most sites of the middle and upper Pleistocene in Germany that have yielded human remains from archaic humans, Preneanderthals, or classical Neanderthals have also produced mammalian faunas that which allow for solid assessment of the ecology as well as for some biostratigraphic correlation.

A typical interglacial Elephas assemblage characterizes all the early sites with remains of archaic humans or artifacts in Central Europe. The site of Mauer near Heidelberg and Miesenheim near Neuwied pertain to the early *Arvicola cantianus* faunas preceding the Elsterian. Bilzingsleben II represents an early stage of the late *Arvicola cantianus* faunas with reduced diversity in rodents and insectivores. These sites are located on the Elsterian till and are most likely Holsteinian in age.

Three other sites, bearing the late *Arvicola cantianus* faunas represent interglacial conditions older than the Eemian. The river deposits of Steinheim/Murr, where the skull of *Homo steinheimensis* was excavated, also produced a very rich interglacial *Elephas antiquus* assemblage from that very same horizon. This horizon is of special interest because it seems that two bovids, *Bos primigenius* and *Bubalus murrensis,* occur at this level for the first time in Central Europe. The specific highly interglacial requirements of *Bubalus* are discussed below with those of *Hippopotamus* in the Eemian faunas. These two taxa are not present at Bilzingsleben and indicate a younger age for Steinheim. Previous correlation with the Holsteinian is thus obsolete. Schöningen 13, which is considered to be younger than Bilzingleben II contains *Bos primigenius* and is thus comparable to Steinheim.

Weimar-Ehringsdorf is a travertine deposit of predominately interglacial character. Human remains and a rich *Elephas antiquus* fauna were excavated from the lower travertine, which is of particular interest here. This site was traditionally regarded as Eemian, but several lines of evidence indicate that this fauna represents an interglacial period within the Saalian complex (OIS 7). *Arvicola* shows an evolutionary level that is intermediate between that from Bilzingsleben and those from typical Eemian sites such as Taubach and Burgtonna. Biostratigraphic correlation between these different interglacial sites is difficult since the typical *Elephas antiquus* assemblages of the upper middle Pleistocene and the Eemian are very similar.

In sediments of the Rhine River at Reilingen, a human calvarium was discovered during commercial quarrying. This sandpit has produced both glacial and interglacial faunal elements. Since high groundwater levels continuously obscure the sediment section, a stratigraphic attribution is difficult. Ziegler & Dean (1998) prefer an older age, while Löscher (1998) argues for an Eemian age. *Hippopotamus* is present at other Eemian sites of the northern Rhine graben.

The classical Neanderthal of the Weichselian coexisted in Central Europe with the *Mammuthus* assemblage and thus lived under glacial conditions. Nevertheless, in this respect, one has to realize that the *Mammuthus* assemblage represents a cold steppe environment and not necessarily the extreme conditions present during the maximal extent of the glaciers. From the last glacial maximum, it is known that the number of large mammals and the human population were strongly reduced, or perhaps even absent. Thus the presence of human remains or artifacts alongside with remains of the *Mammuthus* assemblage does not prove that people occupied the area throughout the entire glacial period.

The Acheulean hand axes from Markleeberg are often cited as the first evidence of humans living under glacial conditions in Central Europe. The gravels at this site are thought to represent glacial conditions in the early Saalian complex. However, no faunal remains have been found directly associated with the tools. These Körbisdorf gravels, which represent the main terrace of the early Saalian, yielded the famous skeleton of *Mammuthus primigenius* from Pfännerhall. But at other sites these gravels produced significant amounts of wood remains, suggesting that the deposits may represent other climatic conditions, not just typical glacial conditions. Thus, there is no clear-cut evidence in regard to the ecology of these deposits.

The loess from Ochtendung has produced very good evidence that Preneanderthals were contemporary with a typical *Mammuthus primigenius* fauna. Human artifacts were excavated together with *Rangifer*, *Coelodonta,* and *Mammuthus* remains. Nearby, at a site with similar conditions, a fragmentary human calvarium was discovered. Age dating of the site is very good, since they are situated on top of small volcanic cones that erupted about 200,000 years ago. These sites are regarded as being about 170 ka old and thus correspond to a late phase of the Saalian complex, most probably OIS 6. The represent the earliest well dated coexistence of humans and the *Mammuthus* assemblage in Central Europe.

The Eemian

During the interglacial conditions of the Eemian humans hunted the various mammals that made up the *Elephas* assemblage. At Gröbern near Leipzig and at Lehringen near Verden/Aller, skeletons of *Elephas antiquus* were discovered together with artifacts, which document the butchering of the carcass, but not necessarily the killing of the animal.

In the ecological reconstruction late Pleistocene deposits of the Rhine River are of great interest, as they have produced both a *Mammuthus* fauna and the typical *Elephas antiquus* assemblage. Years of observations have shown that the glacial fauna comes from the upper part of the section, while thick trunks of black oak (*Quercus* sp.) characterize the lower section containing faunal remains from the last interglacial. In addition to typical taxa of the interglacial fauna, *Bubalus murrensis* and *Hippopotamus amphibius* also occur in several of these sand pits (Koenigswald 1988). Their excellent preservation and frequency prelude the possibility of redeposition from older sediments. Correlation to the last interglacial is plausible due to the geological situation and the very frequent occurrence of *Hippopotamus* on the British Isles during the Ispwichian. The occurrence of *Bubalus* and *Hippopotamus* is fauna is very significant for the reconstruction of the paleoecology. According to the fossil flora the mean annual temperature was only 2° or 3° higher than today. Thus, *Hippotamus* and *Bubalus,* which live in subtropical regions today, do not indicate a paleoclimate, which was much warmer than that of the present day. Extant animals can tolerate lower temperatures but stay in the water to escape from cold winds. That means mild winters but cooler summers. Thus a strong maritime influence on the climate can be postulated for the Rhine area for at least part of the Eemian. This maritime influence certainly tapered of towards the east; at least *Hippopotamus* did not occur farther to the east during the Eemian.

The Weichselian

It is assumed that the *Mammuthus primigenius* fauna immigrated in Central Europe at the beginning of the Weichselian and replaced the interglacial *Elephas antiquus* fauna. However, the palynological record shows several climatic oscillations at the beginning of the Weichselian. In contrast, the faunal record is not complete enough to identify when exactly the *Mammuthus primigenius* fauna came in and in which sequence the various species appeared. The various species certainly expanded their range according to their specific ecological requirements at slightly different times, but this has not been detected yet in the fossil record. This *Mammuthus primigenius* fauna is very similar to that of the late Saalian, and while large mammals cannot be used to differentiate between the two time intervals, the evolutionary level of *Arvicola* may be helpful.

Occupation sites with the Mousterian culture of the classical Neanderthals are known from several cave sites in southern Germany, which show the full diversity of the *Mammuthus primigenius* fauna. Typical sites include Bockstein, Sirgenstein, Blaubeuren, and, most recently Sesselfelsgrotte. They represent glacial conditions most likely with some permafrost but not the phases during which the Scandinavian and Alpine glaciers were at their maximal extent. In northern Germany, the fragmentary human skull from Salzgitter-Lebenstedt was found together with a typical *Mammuthus primigenius* assemblage with *Rangifer tarandus*.

Minor climatic changes such as interstadials do not seem to change the *Mammuthus primigenius* assemblage very much.

The occurrence of *Ovibos moschatus* might indicate restricted periods of especially dry and cold conditions but such finds are not known from the Mousterian layers. The lack of exact dating of fossils older than 50,000 years preclude the determination of whether the Neanderthals had lived continuously in the area during OIS 4.

The fauna does not indicate any significant ecological change at the time when modern man arrived in Central Europe. The *Mammuthus primigenius* fauna remained unaltered until the beginning of the last glacial maximum (LGM), as shown at the various Aurignacian and Gravettian sites. After the LGM, the glacial fauna is characterized once more by a highly continental climate, but the diversity of the fauna is significantly reduced. Thus, changes in the fauna happened distinctly later than the arrival of modern humans.

Conclusions

In Central and Western Europe the major climatic changes that took place during the middle and late Pleistocene led to repeated immigration of the *Mammuthus* assemblage and the *Elephas* assemblage. The immigration of the faunas occurred virtually alternatively and transitional stages are not known. It is more likely that each faunal assemblage underwent local extinction when the changed environment favored the other. During most of the middle Pleistocene, humans occurred in Central Europe during the interglacial periods and seem to have immigrated in together with the interglacial *Elephas antiquus* fauna from the Mediterranean regions. Thus, based on the faunal record and ecological analysis, the series of human remains at Mauer, Bilzingsleben Steinheim, Ehringsdorf, and Neanderthal do not represent a genetic continuity but multiple re-immigrations. Immigration of humans does not necessarily always originate from the same area, e.g. southern France or Spain where continuous human occupation was probable. Immigration of humans from the southeast cannot be excluded during some interglacials, especially when eastern faunal elements occur too, as in Steinheim/Murr.

Even when humans were able to live under glacial conditions alongside with the *Mammuthus* fauna, continuous occupation of the areas north of the Alps is not certain. During the time of maximal extension of the Scandinavian and the Alpine ice shields life in this area was probably not very attractive, for fauna and humans.

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Pleistocene faunal and environmental evolution in Siberia: adding a northeastern dimension to the European story

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Introduction

The last 15 years, especially the 1990's, were a critical period in the Russian fundamental science in general, and in Quaternary sciences in particular. Once rather powerful and collective Quaternary science in Russia disintegrated. The field research, especially in remote regions, shortened dramatically, as well as the number of publications, scientific meetings etc. A few groups and regional research centres managed to continue regular research of Pleistocene mammals, biostratigraphy, and paleoecology, both by excavations and the publication of research results. If we confine ourselves to Siberia, it was first of all the Urals Scientific Centre in Ekaterinburg for the Urals and north-west of Western Siberia, some groups in Novosibirsk for the south of West Siberia, and in Ulan-Ude for Transbaikalia. A common trend was the evident shift of research towards the Late Pleistocene. Early and Middle Pleistocene mammal localities were always relatively rare and restricted to certain areas; many of them now remained out of Russia.

On the other hand, the Russian Quaternary science became "closer to the West", by developing cooperation under many international projects. In the recent years, the number of publications by Russian scientists in international journals increased notably. Currently, the joint activities with European and North American colleagues, new national and international projects allow to hope that we evidence the recovery of active research in Quaternary sciences.

The general sequence of faunal evolution in Siberia

The general scheme of faunal stages for the European USSR based on large mammals has been designed by V.I. Gromov in 1948. Later, the "Gromov's faunal complexes" underwent some revisions, but in general, they are still broadly accepted. The Khaprovian Complex characterized the final stage of the Late Pliocene, the Odessian (Psekupsian) and Tamanian Complexes corresponded to the Early Pleistocene (ca 1.6-0.8 Ma). The Middle Pleistocene, according to V.I. Gromov (1939, 1948), started with the Tiraspolian Faunal Complex, continued by the Khazarian Complex, and ended with the "Late Mousterian fauna", corresponding to the Early Saalian in modern terms. The latest, Upper Paleolithic Faunal Complex, thus embraced the Late Saalian and the whole Late Pleistocene.

It should be noted that the time span between the Tiraspolian and Upper Paleolithic Faunal Complexes was one the most controversial periods in the faunal history. For example, the Khazarian fauna was originally interpreted as an interglacial one (=Likhvin, Holsteinian) (Gromov, 1939, Gromov et al., 1963). Then, the Singilian fauna in the lower Volga area with *Paleoloxodon antiquus*, *Dicerorhinus mercki*, *Elasmotherium sibiricum* and others, accompanied by forest flora (Gromov et al., 1965) was recognized as the Likhvin Interglacial, and the Khazarian one was correlated with the early Saalian and interpreted as the fauna, which existed in open environment and sharply continental climate, i. e., as a glacial fauna.

The subsequent progress in the study of the loess/soil complexes and small mammals from them in the Russian Plain showed a much more complicated story. Currently, A.K. Markova (2006) recognises three warm and two cold intervals between the Tiraspolian (MIS 12) and the Dnieper Glaciation (=Saale, MIS 6); she believes that most of these intervals can be characterized by arvicolid fauna of different evolutionary levels. For example, small mammal assemblage from the type section of the Khasarian (Chyorniy Yar), studied by L.P. Alexandrova (1976), is now referred by Markova to the Kamenka Interglacial (MIS 9). Except this and few other cases, however, the correlation between small and large mammal localities is rather poor. That is why some large mammal students (Dubrovo, 1997) stretch the Khasarian Complex through the whole time span from the end of the Tiraspolian to the end of the Dnieper (s. str.) Glaciation. I.A. Dubrovo also finds unreasonable to separate the Singil Fauna as an independent Complex, at least for Central Russia.

A similar problem appears with the lower limit of the Upper Paleolithic Complex, originally placed by V.I. Gromov in the middle or in the beginning of the Saalian (Gromov et al, 1963, 1965). With the discovery of Shkurlat (=Eemian) interglacial fauna of large mammals and the corresponding localities of small mammals, the Upper Paleolithic Complex was cut to correspond to the Valday (=Weichselian) stage only. Recently, I.A. Dubrovo (1997) suggested to recognize the Perervian Complex for the Late Saalian, but its difference from the Upper Paleolithic one is not evident.

All those main and additional faunal complexes have been recognized in the European part of the former USSR, and even here there are some problems. Jumping over the Urals to Siberia, we face the same problems, but much more pronounced.

During the peak of research activities in Quaternary paleontology and biostratigraphy in the 1960-70's, the general trend was to reveal the analogs of Gromov's faunal complexes further east. With a single exclusion, the best results were obtained in the southern part of Siberia. In the south of West Siberia, E.A. Vangengeim, V.S. Zazhigin (1959) and others recognized the Podpusk-Lebyazhyian Complex as an analogue of the Khaprovian, the Kizikhian, a suggested equivalent of the Odessian, the Razdolyian as the closest analogue of the Tamanian, and the Vyatkinian as a possible Siberian equivalent of the Tiraspolian. Tatarka Fauna and its correlatives on the Irtysh River with *Ursus spelaeus rossicus,* *Palaeoloxodon* ex gr. *antiquus*, and abundant *Megaloceros* sp. was correlated with the Tobolsk Interglacial and, correspondingly, with the Singilian (Likhvin) fauna of the European USSR (Vangengeim, 1977). Further up the sequence, however, only some "elements" of the Khasarian fauna were recognised, neither equivalents of the Last Interglacial (Kazantsevian =Eemian) faunas, nor of the MIS 3 (Karginskian) were found, and the Upper Paleolithic ("Mammoth") Complex has been suggested to exist since the Late Saalian to the end of the Pleistocene, with possible subdivision into early and late stages, based mostly on *Mammuthus primigenius* dentition morphology.

In Transbaikalia, more or less close equivalents of the Odessian, Tamanian, and Tiraspolian Complexes were recognized – the Dodogolian, Itantsinian, and Tologoyian respectively (Vangengeim et al., 1966)[1]. No one faunal assemblage was classified as an "interglacial" or "interstadial" during the whole Middle and Late Pleistocene (Vangengeim, 1977).

Finally, north-eastern Siberia was the only area in Eurasia, where the Late Pliocene, the Early and early Middle Pleistocene mammal faunas were found beyond the Arctic Circle. The Olyorian Fauna of northern Yakutia (Sher, 1971) was at first interpreted as an equivalent of the Tiraspolian (=Elsterian) faunas of Europe, based on many common taxa, which presumably had the same evolutionary stage (*Equus* ex gr, *sussenbornensis*, *Cervalces* ex gr. *latifrons*, *Praeovibos* ex gr. *priscus*, *Gulo* ex gr. *schlosseri*, *Allophaiomys* ex gr. *pliocaenicus* and primitive *Microtus* s. str., and many others). However, the subsequent research, including detailed biostratigraphic, paleontological and paleomagnetic studies, revealed that the time span of the Olyorian Land Mammal Age (Sher, 1986) covered not only the Tiraspolian and Tamanian ages, but at least a part of the Odessian as well (Sher et al, 1979; Virina et al., 1984; Lister and Sher, 2001).

The problems with the Middle Pleistocene faunas in Siberia.

The faunal assemblages of the Tiraspolian type are probably the latest, rather easily distinguishable from the subsequent ones by many characteristic species of large mammals. The problems start with the Khasarian. In European Russia, the characteristic elements of the Khasarian Complex among large mammals are *Mammuthus chosaricus, Elasmotherium sibiricum, Camelus knoblochi, Megaloceros giganteus, Bison priscus longicornis* (Gromov, 1935). Additionally, in the type locality of Chyorniy Yar on the Volga River, *Equue caballus chosaricus* and *Saiga tatarica* fossils were found (Alekseeva, 1990). Such a combination has never been found in Siberia, and the known records (mostly, in West Siberia) of one or several members of this list can hardly prove their relation to the Khasarian Complex. The taxonomic status of some of these species (*Mammuthus, Bison, Equus*) and, correspondingly, their identification, are debatable, while the others (*Elasmotherim, Camelus, Megaloceros, Saiga*) had much broader chronological ranges. That explains why in the Urals and southern Siberia only scattered "elements of the Khasarian Complex" are found (Vangengeim, 1977; Kosintsev, 2003). There are even less chances to recognize the large mammal fauna of the Khasarian type in northern Siberia. The assemblages, which could belong to that time span, are hardly distinguishable from typical "Mammoth" (Upper Paleolithic) fauna by their composition of large mammals.

A little better chance is offered by small mammals. However, the key Khasarian vole species in European Russia is *Arvicola chosaricus* (Alexandrova, 1976), so far not found in Siberia. More promising for Siberia is the rapidly evolved lineage of collared lemmings (*Dicrostonyx*). Fossils of this genus are very common in Middle Pleistocene deposits of the North-East of Asia, West Siberia, the Urals, and even European Russia. In north-eastern Siberia, this lineage has been even used for the regional stratigraphic chart as a key fossil with 5-6 subsequently evolved species (Zazhigin, 1976; Sher et al., 1979). It was believed, until recently, that one of the species in that lineage, *D. simplicior* Fejf.*,* was the key fossil for the whole Middle Pleistocene. Some recent collections, however, made V. Zazhigin to undertake the revision of the Middle Pleistocene members of this lineage, which is still in progress (Zazhigin, 2003; Sher et al., in preparation).

The latest Middle Pleistocene assemblages of large mammals seem to be hardly distinguishable from the later "Mammoth" fauna in the Urals (Kosintsev, 2003), west and east Siberia (Vangengeim, 1977), and the North-East (Sher, 1971/1974). The attempts to discriminate "early" and "late" (and sometimes, even "intermediate") variants of the Upper Paleolithic Complex, or "Mammoth Fauna", by large mammal fossils do not seem very optimistic now. Such ideas were based mostly on details of mammoth dentition morphology and the body size of caballine horses. Some recent works show that the geographic variation of these parameters over the huge space of Eurasia could override the chronological trends within the same species (e.g., Lister and Sher, 2001), and such characters cannot be used for biostratigraphy.

1 The Itantsinian Complex is now referred to the Late Pliocene, and three new complexes based on small mammals are recognized between the Dodogolian and Tologoyian (Alexeeva, 2005).

The problem of the Last Interglacial and MIS 3 „interstadial“ faunas in Siberia

The Last Interglacial (Mikulino=Eem) assemblages in European Russia are recognized mostly on small mammals (Markova, 1985, 1990). The best large mammal assemblage, referred to this age, is Shkurlat in Voronezh Region (Alekseeva, 1980). The assignment of this locality to the Eemian is based on the combination of an “advanced form” of *Palaeoloxodon antiquus* with the “archaic form” of *Mammuthus primigenius* (“early form”). Taking into account the recent understanding of woolly mammoth evolution (Lister and Sher, 2001; Lister et al., 2005), we cannot accept at least the last argument. Even at the western slope of the Urals, only one site (Makhnev Cave) is referred to the Eemian because of the presence of *Histrix* and *Ursus thibetanus* (?), but not a late straight-tusked elephant or early mammoth (Kosintsev, 2003). Further east, in West and East Siberia, Transbaikalia and north-eastern Siberia, the Last Interglacial faunas have never been recognized (Vangengeim, 1977; Alexeeva, 2005; Sher, 1991).

In general, the large mammal fauna of the Late Pleistocene in Siberia is very homogeneous. The age definition of fossil assemblages is based mostly on radiocarbon dating and local geology. That probably explains why the assemblages referred to the last 50 thousand years are much more numerous than the earlier ones. A common argument to refer any local fauna to the Zyryanian (early Weihselian) is uncertain radiocarbon age (beyond the limit of the method), but the composition of fauna by itself is not very helpful.

The key problem of the Late Pleistocene in Siberia is the interpretation of environment and climate of the so-called Karginskian Interstadial (Middle Weihselian, equivalent of the MIS 3). The former concept of a long and complicated “megainterstadial”, with three “warm” and two “cold” intervals (Kind, 1974) is a subject of serious criticism in the recent years (e.g., Astakhov, 2001). In north-eastern Siberia, the study of a continuous section in the Lena Delta recently allowed us to suggest a new interpretation of this period (Sher et al, 2005). In the cited paper, we examined the “Karginskian problem” in detail. Vangengeim (1977) failed to recognize peculiar mammal faunas of the “Karginskian” age in Siberia and concluded that the environment and climate of that time probably did not affect the existence of “mammoth fauna”. Extensive recent work in some regions, however, suggested that minor variations in the composition of faunal assemblages of that time can be noticed, but mostly in the southern regions, such as Southern Urals (Kosintsev, 2003) and Transbaikalia (Alexeeva, 2005).

The mammals of Mousterian sites in the Altay

This review would be incomplete if it ignores the question of mammals that accompanied the so-called Mousterian lithic industries in Siberia. Such industries are known from southern Siberia, especially in the Altay Mountains, and are believed to document the presence of Neandertal people (Vasilyev, 2000). The best studied sites are Denisova Cave, Okladnikov’s Cave, Strashnaya Cave, Ust’-Kanskaya Cave and the open site Kara-Bom, all in the Altay region. The most general feature of large mammal fauna is that it includes common members of Mammoth Fauna in combination with mountain, and sometimes desert species. Fossils of mammoth itself are rather rare, but horse, woolly rhinoceros and bison are quite common, as well as sheep and goat; saiga antelope fossils were found in some sites. Red deer fossils occur much more frequently than reindeer. Most of the cave sites have abundant fossils of *Crocuta spelaea*, and some – of a small cave bear. Interesting is the presence of such “eastern “ species, as the antelope *Spiroceros kjakhtensis* and yak *Poephagus* sp. The “southern” elements include such species as zeren (*Procapra* cf. *gutturosa*), kulan (*Equus hemionus*), Pleistocene ass *Equus* cf. *hydruntinus*, and even jerboa *Allactaga* sp. (Tseitlin, 1979; Derevyanko et al., 2000; Vasilyev, 2000).

Thus, the Altay “Mousterian” assemblages put together some species, which were very common in Europe, but did not spread across Siberia, and are found there mostly in the south (cave bear, wild ass), with the species of clearly east- and central-asiatic distribution (spiroceros, yak, zeren). Probably, the spotted (cave) hyena had the most characteristic Pleistocene distribution to represent those kinds of faunal assemblages. All mammals, listed in this paragraph, has never been found in north-eastern Siberia. On the other hand, the Altay “Mousterian” assemblages show evident lack or rare occurrence of the most arctic-adapted members of Mammoth Fauna. Thus, if such industries really belonged to Neandertals that changes the J. Stewart’s idea that those people were “European peninsular endemics” (Stewart, 2004), but corroborates his thought that they were not “arctic-adapted”.

Conclusion

The main feature of Siberian environment in the Pleistocene, like at present, was the continentality of its climate. The composition of interglacial faunas in Europe evidently shows the increasing climatic continentality towards the Urals. In Siberia, the continentality reached its peak beyond the Verkhoyansk Ridge in the North-East, under relatively low levels of temperature. The climate cooling started here very early, and the low-temperature permafrost appeared here not later than 2.5 mln years ago (Sher et al., 1979). In Transbaikalia and Northern China permafrost appeared also relatively early, at the end of the Early Pleistocene (Alexeeva and Erbajeva, 2000).

To a certain degree, high continentality and early cooling affected all Siberian faunas. That caused generally more “flattened” pattern of faunal evolution in Siberia against Western Europe. In the north of West Siberia, for example, mammal complexes of tundra, forest-tundra and tundra-steppe type dominated through the whole Pleistocene; no alteration of “glacial” and “interglacial” faunas was revealed there (Smirnov et al., 1986). In western Transbaikalia, steppe and desert species dominated the small mammal fauna during the Pleistocene; no true forest assemblages were found there, although pollen data suggest the appearance of scattered forests and forest-steppe landscapes during some periods (Alexeeva, 2005). In north-eastern Siberia, where the glaciers never appeared on the vast plains, mammal and insect assemblages of tundra-steppe type appeared more than one million years ago, and with minor variations persisted until the Pleistocene/Holocene transition (Sher et al., 2003). Due to that, north-eastern Siberia (Western Beringida) was the region, where many species evolved, adapted to tundra-steppe environment, such as woolly mammoth, musk-oxen, some voles and lemmings, and probably some other species.

Only the mountain areas in the south of Siberia, such as Altay, could support a richer vegetation mosaic and more diverse mammalian fauna during the Pleistocene.

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Symposium 3: Neanderthal lifeways, subsistence and technology

Conveners: NICHOLAS CONARD & JÜRGEN RICHTER

Respondent: PAUL A. MELLARS

This symposium will present the key archaeological data and ideas that have allowed researchers to reconstruct the lifeways of the Neanderthals. The speakers draw examples across the temporal and spatial range of Neanderthals and critically assess current interpretations. Lectures will address patterns of subsistence and nutrition based on faunal and isotopic analyses. Lithic artifacts and ,when preserved, organic artifacts provide insight into the technology that Neanderthals used in the diverse geographic and climatic zones that they occupied. By pooling the information available from multiple sources, speakers will critically examine models for land use, demographic patterning, and social structures to present an up-to-date assessment of the behavioral patterns of the Neanderthals.

Diet and ecology of Neanderthals

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One hundred and fifty years after the discovery of the Neanderthal fossils in Feldhofer cave, scholars are still debating about the reasons why this hominid form is not around any longer. Several hypotheses dealing with the extinction of Neanderthals involve the diet and ecology of this hominid. One may think that after one century and a half of scientific studies, these aspects of this hominid palaeobiology are reasonably well known. A very large number of palaeoanthropological, palaeontological, palaeobotanical, geological, and palaeoclimatic data have been gathered thanks to the investigations of many research groups. These works lead to interesting hypotheses on the diet and ecology of Neanderthals, but the conclusions of these investigations do not always provide a consistent picture of Neanderthal way of life and many aspects, including diet and ecology, are still controversial. For instance, questions such as: „was the diet of Neanderthals different from the diet of anatomically modern humans?" and, „were Neanderthals more cold adapted than anatomically modern humans?" still remain with no firm and definitive answers.

Most of the problems come from the geographical disjunction between palaeoclimatic indicators, which are found mainly in polar icecaps, as well as marine, lacustrine, and loessic sediments, and the sites where the Neanderthal fossils and settlements are found. Potential palaeoenvironmental indicators are also found in the sites themselves, in the form of fossil mammals, fossil plants and geological features. However, it is not always straightforward to associate the last two tracers with human occupation, and the use of fossil mammals as palaeoecological tracers presents some difficulties. Indeed, these fossil mammals are partly ancient representatives of extant species, such as reindeer, red deer, roe deer and horse, and partly extinct species, such as woolly rhinoceros and woolly mammoth. In the case of extant species, the basis of the palaeoecological interpretations is taxonomic uniformitarianism. This implies that ancient representatives of a species have the same ecological requirements (range of temperature, humidity, food resources) than the modern representatives of the same species. Such an assumption is reasonable but presents some problems. Firstly, the modern geographical (and climatic) ranges of the taxa do not extend to the maximum area (and climatic conditions) possible. Secondly, fossil assemblages are often mixtures of species that do not cohabit in the modern world. Is this due to time averaging of the assemblages, or to the actual existence of „non-analogue communities" (communities including species that have non-overlapping distributions in the modern world), meaning that the ecological requirements of a species can change through time? This question raises interesting implications about the fact that fossil taxa may not be identical to modern ones, as they may represent different genotypic populations. The case of extinct species palaeoecology is even more complicated since assumptions have to be made based on skeletal remains, sometimes fragmentary, and they are therefore less secure than the conclusions based on extant species.

In this context, a new disciplinary field, bone isotopic biogeochemistry, yields new data since about 15 years (Bocherens et al. 1991). These data, in addition to the results of other fields of research, can provide valuable insight on the diet and ecology of Neanderthals. This approach is based on the fact that during an individual's life, its tissues, including bone, incorporate carbon and nitrogen atoms that reflect the isotopic composition of the consumed food. Since different food items can be distinguished through their carbon ($^{13}C/^{12}C$) and nitrogen ($^{15}N/^{14}N$) isotopic signatures, information about the diet of fossil hominids can be retrieved, as well as information about the life environment of animals found in prehistoric sites. In particular, plants growing under a closed canopy exhibit significantly less ^{13}C than plants growing at the top of the canopy or in open environments, such as open woodland, grassland, steppe and tundra. The tissues of herbivores consuming plants from a closed canopy will also exhibit lower $^{13}C/^{12}C$ than those of herbivores consuming plants from an open environment. The $^{15}N/^{14}N$ ratios of an animal are always higher by a relative constant factor than those of its food (e.g., Bocherens and Drucker, 2003). Therefore, it is possible to reconstruct the trophic position of a fossil individual using both pairs of isotopes, $^{13}C/^{12}C$ and $^{15}N/^{14}N$. However, the use of this approach is possible only when skeletal remains still contain well-preserved collagen. This is often the case in cold cave deposits for several dozens of thousand years, making Upper Pleistocene Middle Palaeolithic sites within the reach of this approach (Bocherens et al., 1999). In warmer climates, as in Mediterranean Europe, and in open-air sites, bone is usually less well preserved and collagen is often too altered to yield reliable isotopic signatures. In such cases, it is nevertheless possible to measure carbon isotopic signatures in the mineral fraction of tooth enamel (e.g., Bocherens et al., 1995). These data provide information about the density of the vegetation cover consumed by herbivores that lived in the surrounding environment of Neanderthals and were hunted by them, and therefore about the ecology of these hominids.

Investigations of the diet of about 25 Neanderthal individuals have been attempted using this new isotopic approach, but only 12 specimens yielded well-preserved collagen, ten of them having been published. Unfortunately, specimens from Les Pradelles, Artenac, Bourgeois-Delaunay, and La Chaise-Suard in France, Vindija in Croatia, and Dederiyeh in Syria, did not yield well-preserved collagen (Ambrose 1998; Bocherens et al. 2005; Higham et al. 2006; Bocherens unpublished). For the remaining specimens, isotopic evidence points to dietary proteins coming from herbivores living in open environments, even in cases with evidence of closed canopy forests around the site. For instance, the Neanderthal specimen from layer 4A in Scladina, contemporary to Oxygen Isotope Stage 5c, exhibits high $^{13}C/^{12}C$ and $^{15}N/^{14}N$ ratios indicating the consumption of meat from herbivores living in open environments, while some herbivore specimens from the same layer exhibit much lower $^{13}C/^{12}C$ ratios similar to those of modern herbivores living under closed canopy forests. In this context, forested and open environments were present around the site but the Neanderthal specimen focused its diet on herbivores from the open environment, neglecting the game from closed forest (Bocherens et al. 1999). In the case of Saint-Césaire I Neanderthal, it was possible to apply a mathematical model allowing the quantification of consumed prey, thanks to the richness of ungulates available for isotopic analysis that exhibit different isotopic signatures. The results show that meat of megaherbivores, such as mammoth and woolly rhinoceros, was high in the diet of this Neanderthal, while meat of smaller ungulates, such as reindeer, was barely consumed. The same approach applied to hyaenas from the same sites shows that their diet was mostly based on medium sized herbivores, such as bison, horse and deer, suggesting that the meat of megaherbivores was not available in the form of carcasses. Therefore, Neanderthals probably have actively hunted the very big herbivores to obtain their meat (Bocherens et al., 2005).

The isotopic study of Neanderthal diet will always be limited due to the relatively small number of bones available, and the even smaller number of bones with well-preserved collagen. However, the isotopic approach can yield very valuable results in the determination of Neanderthal ecology by providing data on the environment where the mammals found in the same sites used to live. This approach can also be used to test hypotheses about the ecological valence of ancient representatives of extant species (the " taxonomic uniformitarianism " principle) and about the range of ecological preferences of extinct species. The preferred habitat of herbivores as well as the preferred prey of animal predators that co-occurred with Neanderthals can be directly evaluated using this approach. It is therefore possible to infer land use for food resources as well as potential dietary competition between Neanderthals and other mammals during the Late Pleistocene.

The isotopic results gathered on herbivores that lived under different climatic contexts since 120,000 years demonstrated the ecological flexibility for some species. This is not surprising for species such as red deer and roe deer, which modern representatives occupy various habitats, from open steppes to closed forests (Geist 1999). These ecological flexible taxa can now be used as tracers of terrestrial environments thanks to their isotopic signatures (e.g., Drucker et al. 2003). Other species, which are classically considered as good markers of a narrow range of habitats, have been found to be more flexible than expected. For instance, horses from Belgium, dating from the

Eemian *sensu lato* contemporary to Oxygen Isotope Stage 5c and 5d, exhibit very low $^{13}C/^{12}C$ ratios in their bones and teeth, indicating the consumption of plants growing under closed canopy forests. Preliminary data also suggest that mammoths and reindeer could well live in dense forests during this period. Using the isotopic approach offers us the possibility to evaluate the actual preferred habitat of ancient mammals, independently of their taxonomic attribution. Combined with zooarchaeological investigations, this new approach provides more refined palaeoecological reconstruction for Neanderthals, especially in non-analogue communities.

The comparison of collagen isotopic signatures in Neanderthals and animal predators, such as bears, hyaenas, lions and wolves, shows that each type of predator exhibit different values. On one extreme end, cave bears present very low $^{15}N/^{14}N$ ratios that indicate a purely vegetarian diet (Bocherens et al., 1994). On the contrary, Upper Pleistocene brown bears exhibit high $^{15}N/^{14}N$ ratios typical of consumers of ungulate meat, as well as hyaenas, lions and wolves. However, the isotopic values of these different predators are clustered according to the species, which suggests different prey preferences for the coeval predators. In this context, Neanderthals present higher $^{15}N/^{14}N$ ratios than animal predators, which point to the preferred consumption of meat from herbivores with high $^{15}N/^{14}N$ ratios, identified as megaherbivores, such as mammoth and woolly rhinoceros. Therefore, there is no indication of dietary competition between contemporary Neanderthals and animal predators. On the contrary, the few available isotopic data do not preclude dietary competition between the last Neanderthals and early anatomically modern humans in Europe (Drucker and Bocherens, 2004; Bocherens and Drucker, in press).

Significant progress has been made during the last decade on the diet and ecology of Neanderthals, especially with the addition of the isotopic approach to the other fields of palaeoecological research. In parallel to the spectacular progresses that are currently made in modern ecology using this new approach, it is anticipated that even more significant breakthroughs will be performed during the next decades of palaeocological research on late Pleistocene terrestrial ecosystems, with implications on the reconstruction of the diet and ecology of Neanderthals.

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Neanderthal lithic technology

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Aujourd'hui, nous sommes capable de mieux percevoir les réalités techniques propres aux productions des artefacts lithiques de différentes occupations archéologiques, grâce à l'évolution des méthodes de lecture dont la technologie. Il n'en reste pas moins que cette perception de la réalité pour les périodes qui nous concernent (de 2.5 Ma à 40 .000 ans) reste superficielle, à double titre.

En premier lieu, de la réalité de ces hommes de la préhistoire, nous ne percevons que les moyens de production et en aucun cas les objectifs, en effet, excepté à de rares occasions, nous ne connaissons rien de la finalité des outils qui nous parviennent, puisqu'ils sont désormais en dehors de notre mémoire collective. La tracéologie a essayé d'y remédier mais, pour différentes raisons, les résultats restent ponctuels et fractionnaires. La technologie, elle, ne s'est jamais intéressée aux outils, se limitant à une détermination purement typologique, essentiellement inspirée de l'approche du Prof. F. Bordes. Pour finir, les études techno-fonctionnelles qui prennent en compte l'ensemble des artefacts, de la production au fonctionnement des outils, sont très récentes.

En second lieu, lorsque nous essayons de comprendre ces artefacts à travers le temps, dans notre cas sur le temps long, il nous est impossible d'articuler nos données de façon cohérente. Cette incohérence est due à des disparités de méthodes d'analyse, mais surtout à un manque de perception globale susceptible de permettre de considérer la réalité technique sur le temps long. En effet, notre perception qui est basée sur la détermination de l'individualité et de la spécificité des artefacts reste essentiellement synchronique à un temps donné et en un lieu donné. Or, sur le temps long comme le dit Simondon on se rend compte que cette spécificité est illusoire : « car à aucune structure fixe ne correspond un usage défini. Un même résultat peut-être obtenu à partir de fonctionnement et de structures très différentes ». Ainsi, tant l'individualité que la spécificité d'un objet est très instable d'un groupe à l'autre ou d'une culture à l'autre.

C'est pourquoi nous préconisons de renverser le problème et de considérer que c'est à partir des critères de la genèse que l'on peut définir l'individualité et la spécificité de l'artefact technique. Autrement dit, chaque objet s'inscrit dans une lignée « phylogénétique » dont il faut saisir le sens temporel de son évolution. Un objet n'est pas tel ou tel artefact donné en un temps et en un lieu donné mais le fait qu'il est seulement un stade défini de l'évolution, avec un avant et un après éventuel.

En fonction de ces deux constats, nous proposons les bases d'une nouvelle méthode de lecture capable de rendre compte d'une réalité technique synchronique et diachronique plus complète, ou tout du moins plus cohérente et heuristique, permettant de rendre compte de la modalité évolutive logique qui met en relation de causalité réciproque l'évolution des outils et des modes de production. Ainsi sont mis en évidence des lignées et des cycles d'évolution au sein desquels l'humain et la technique sont des co-facteurs de cette évolution.

Social organisation and settlement dynamics of Neanderthals

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The Neanderthals of 2006 are very different to those of 1956 and 1906. One hundred years ago the preferred means for estimating their settlement and society was by direct comparison with Australian Aborigines (Sollas 1911), while fifty years ago the contributors to *Der Neanderthaler und seine Umwelt* (Tackenberg 1956) restricted their discussions to descriptions of bones, stones and physical environment. While it is a commonplace to state that every age gets the Neanderthals it either deserves, or wants, there has however been a sea-change in these just-desserts and needs. Our approach to the study of these, and many other fossil hominins, has become more inclusive, while at the same time the limitations to investigating their societies and settlements, apparently imposed by the paucity of their archaeological traces, have been overcome. It has taken one hundred and fifty years, but Neanderthals have now emerged as humans with a difference. Indeed, for many archaeologists they are currently much more interesting than the so-called Modern humans who appear in the late Middle Pleistocene and are criticised (e.g. Renfrew 1996, Watkins 2004) for not getting down to the invention of agriculture for at least another 150,000 years. Since Neanderthals have never been associated with domestication and the rise of civilisation it is possible to view them without the distorting lens of future accomplishment. Such teleologically neutral hominins allows us to assess their social skills and their use of landscapes, and by so doing understand something of these humans with a difference.

The theme of this paper will be to examine the archaeological evidence for the hold of social proximity on Neanderthal life (Gamble 1999). The comparative lack of social extension in Neanderthal society, what would be regarded as a release from social proximity (Rodseth et al. 1991), is the starting point for investigating their social structure. It can be demonstrated that the construction of Neanderthal society was predominantly face-to-face and the degree to which relationships could be maintained when members were absent does appear to have been a constraint of geographical expansion. These constraints were also subject to the climatically determined patterns of environmental change and resulted in repeated geographical ebb and flow among populations within Europe (Davies and Gollop 2003, Gamble et al. 2004).

The mechanisms by which social bonds were enacted and maintained in Neanderthal society is therefore of considerable importance. Much, for example, has been written about Neanderthals and language (e.g.Lieberman 1989). Recently the social brain hypothesis (Aiello and Dunbar 1993, Dunbar 2003) has argued for an early, pre-Neanderthal date, for the appearance of language, and in this paper I will explore the implications of this model. In particular, spoken language is only one means by which the metaphors that are so critical to social relationships can be expressed. Stone tools, and material culture generally, form part of a social technology that expresses metaphors in a solid form (Tilley 1999). In other words, many of the complexities of social life that we attribute to language no doubt pre-ceded it in the form of these material metaphors. Neanderthals, as I will show, were therefore possessed of a richly textured social life dependent upon abstract concepts since they combined these earlier forms of solid metaphor with linguistic ones.

The complexity of Neanderthal social life is well illustrated by their settlements. As Kolen (1999) has shown it is difficult to interpret their ‘huts’ and ‘houses’ recovered from excavations. Rather than adaptive solutions to living on the glacial steppes of the Ukraine, or adapting the interiors of rock-shelters at Arcy-sur-Cure, these accumulations present rational puzzles more linked to the mechanics of the body than the engineering of the mind. But these logical puzzles, as Verpoorte (2001) has claimed at the *Homo sapiens* locale of Dolni Vestonice, are not confined to Neanderthals. Instead such ‘living’ structures are ‘social’ constructions where disparate elements – stones, bones, pits, bodies, art – have been brought together and relationships created. They seem to be more the work of the bricoleur (Lévi-Strauss 1966) than the engineer, and where the interest is on making metaphorical connections between the worlds of things and people rather than coming up with engineering solutions to wet and cold weather.

The next 50 years will be interesting ones for Neanderthals. I will end my paper by exploring the major difference they show to other humans. Archaeology has convincingly established that all hominins, except *Homo sapiens* from about 60,000 years ago, were restricted to a segment of the Old World. These distributions need to be explained. Using the ideas of changing material metaphors during human technological development, I will show how the categories of kinship, the ultimate in formal social organisation, arose and transformed humans into a global species.

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Neanderthal subsistence behaviour in northwestern Europe

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The Middle Palaeolithic is characterised by climatic instability and climate fluctuating with rapid shifts of temperatures possibly even within the lifetime of an individual. Climatic shifts and the resulting variety of environmental responses would have led to a constant shift in the quality and quantity of ungulate biomass in a given area.

Neanderthals must have responded dynamically especially to the selection pressures connected to cold environments. In fact, the archaeological record shows that their foraging strategies were directed towards highly specialized large-game hunting involving a variety of tactics but always focussing on better quality animals and parts thereof.

This can be demonstrated by monospecific - or species-dominated faunal assemblages which are known from the beginning of the Middle Palaeolithic onward, displaying a variety of exploitation strategies, as well as by faunal evidence from Eemian (MIS 5e) sites.

Only at the end of the Middle Palaeolithic starting from approximately 50.000 do we witness occasional exploitation of small game which is still ephemeral in character and cannot be interpreted in terms of a broadening of the dietary niche, e.g. what had been documented for the late Upper Palaeolithic Magdalenian period.

Hunting weaponry uncovered at the German site of Schöningen (ca. 400.000) as well as evidence from the Israeli site of Gesher Benot Ya'aqov indicates that Neanderthals did not invent regular large-mammal hunting, as occasionally suggested. But Neanderthals seemed to have perfected it by focussing on only high nutritional resources

The economics and organization of Neanderthal technology

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Neanderthals present Paleoanthropologists with as series of paradoxes. Are they primitives with unexpectedly large brains or essentially modern humans with heavy faces and massive skeletons? There are similarly contrasting perspectives on their material culture. Some researchers emphasize the simple and unplanned features of Middle Paleolithic stone tools, whereas others point to apparently sophisticated, complex features within the same industries and assemblages.

Two perspectives dominate the study of Middle Paleolithic stone artifacts today. The first is the characterization of *chaînes opératoires*, more specifically methods of blank production. The second centers on the analysis of raw material economies, the economic dimensions of artifact production and use. Most studies of *chaînes opératoires* intended to elucidate cultural traditions, adaptively neutral and largely unreflective bodies of knowledge about how to do things. Studies of raw material economy are aimed more specifically at understanding adaptations, how factors external and internal to Middle Paleolithic societies affected the behavior of Neanderthals and their contemporaries.

These two very different approaches to understanding Paleolithic artifacts are complementary rather then competing, as each casts somewhat different light upon the cognition behavior of Neanderthals. Both kinds of study have shown us a hominin that was technologically adept, highly flexible, and capable of dealing with a diversity of problems in production, provisioning and application of artifacts. The numerous studies subsumed under these two broad themes show much that is familiar about how Neanderthals made and used stone tools, but some things that are strange as well.

This presentation covers the second perspective. It is organized around the notion of the role(s) of technology in human society. Modern humans as a species are dependent on technology, and material culture, for their survival. More than just an interface with the environment, technology today pervades virtually every facet of human society, from basic communication to reproduction to religion. The pathway to this extraordinary technological dependence is one of the great stories of human evolution, and Neanderthals illustrate one of the most recent chapters in that story.

A few basic principles and assumptions underpin studies of raw material economies. A central problem for users of stone tools (or any other kind of material culture) is keeping supplied with the finished implements and raw materials needed in their daily lives. For organisms that are not actually dependent on technology, keeping supplied is not a major concern: they can do without tools if needed, and it may not even be worth the trouble to make them and carry them around. The survival of an animal, like humans, and indeed like Neanderthals, that is more completely dependent on technology , depends on making sure that artifacts are available when and where they are needed.

Three things complicate the process of maintaining a supply of material culture. First, there is the cost of making things. In the case of Middle Paleolithic stone tools these costs are minimal. More important is the spatial dis-congruity between places where tools are needed and places where appropriate raw materials can be collected. Flaking stone requires rocks with specific properties (such as homogeneous, vitreous character and conchoidal fracture). In some environments usable stones are quite common whereas in others they are rare and difficult to find. However, no place can people count on having useful stones at hand wherever and whenever they need them. Mobile hunter-gatherers (and Neanderthals were indeed mobile, to some extent) encounter third problem: because they move around, it can be difficult to predict just where needs for tools and implements will arise.

By studying the ways Neanderthals produced stone artifacts, how they moved tools and raw materials about the landscapes that they inhabited, how they maintained their artifacts, and when they decided to throw things away, we can gain important insights into how Neanderthals responded to these problems in maintaining a supply of usable artifacts while moving around in an uncertain raw material environment. This in turn tells us about both the conditions these hominins faced and about the hominins' capacities and tendencies in responding to conditions.

A number of European researchers have studied how Neanderthals utilized the diverse raw materials their environments afforded. Information about which raw materials were preferred and which sources exploited tell us about the scale of human use of the landscape as well as about strategies for making artifacts available where and when needs arose. The unique challenges of attributing artifacts to particular geological source areas are met with a battery of techniques, ranging from simple visual identification to analyses of trace element abundances using mass-spectrometry.

Several studies have examined the spatial scale of raw material transfers in the Middle Paleolithic. Research by J-M Geneste in southwest France has been especially important and influential. Geneste showed that Neanderthals often carried artifacts and raw materials over appreciable distances, up to 50-60 km in his study area. This scale of transport demonstrates that they habitually carried some tools over a series of days in anticipation of future needs. Geneste (and others) also demonstrated that Neanderthals selected certain kinds of objects to carry with them; the preferential transport of Levallois flakes in particular indicates that they actively selected objects which provided the greatest utility for their weight (Geneste 1988a-c, 1990). Synthetic studies of Middle Paleolithic raw material transfers by A. Feblot-Augustins show that scales of raw material transport varied across different habitats. For instance, maximum distances of raw material movement in eastern Europe are much greater than in western Europe or the Levant. This contrast may well reflect differing scales of mobility and larger territories on the open plains of eastern Europe and elsewhere (Féblot-Augustins 1993; Roebroeks et al. 1988; Wengler 1990). However, the effects of differing geological substrates and raw material distributions must also be considered.

An alternative approach to understanding the economics of raw material focuses on the "life histories" of artifacts. Studying techniques for prolonging the usefulness of tools and for getting the most out of available raw materials show how ancient toolmakers coped with perceived and predicted shortfalls of useable stone, how they balanced the costs of transporting toolkits against the risk of running short of vital technological aids. A wide range of studies show that Neanderthals were sensitive to the overall abundance of appropriate raw materials in the environment, such that when stone was in short supply they took obvious measures to conserve it (e.g., Dibble 1991; Jelinek 1991). However, the availability of stone is only part of the equation. The life histories of Mousterian artifacts also vary with how tool-users moved about the environment, whether they were constrained by the need to carry their entire toolkits form place to place or whether they could stockpile stone at places they stayed for a long time (Kuhn 1992, 1995). Conard and Adler (1997) have reconstructed a particularly illustrative vignette capturing Mousterian hominins replenishing their toolkits.

The overall picture obtained by studying Neanderthal technology from an economic perspective is of a hominin highly dependent on technology. They could cope with vast range of situations, from the best to the worst kinds of stone, from places where flint was abundant to places where it was exceedingly hard to get. They took clear measures to make sure tools and raw materials were on hand when needed: they accomplished this by judiciously selecting the most efficient artifacts to carry with them, by carefully conserving tools when needed, as well as by being profligate when conditions allowed it. Most of what we know of Neanderthal technology comes from studies of stone tools, but emerging evidence from pyrotechnology and other areas suggests a similar degree of flexibility.

Its complexity and elegance notwithstanding, Neanderthal material culture, like that of earlier hominins and unlike what came (a short time) later in the Upper Paleolithic, is fundamentally a practical, utilitarian enterprise. Many artifacts have esthetic value to us today, and some methods of production are impressively designed and executed. Neanderthals almost certainly found their artifacts pleasing, and surely cared about how they made them. Any organism that depends on a certain set of behaviors for its survival is likely equipped by evolution to take enjoyment from them. But it is difficult to find evidence of Neanderthal technology entering into the symbolic or social realms of hominin culture. There is no clear added esthetic value, in the sense of attributes added to artifacts "just for appearance." With the possible exception of pigments, there no purely non-utilitarian classes of material culture in the archaeological assemblages created by Neanderthals. Archaeologists have identified a great deal of variation in ways of making things and in the forms of final products across space and over time. However, the use of technology for expressing social boundaries is not clearly manifest in the material record of Neanderthals: we have no compelling reason to argue that the observed variation represents anything other than natural divergence of cultural traditions far-separated in space and time. (Admittedly, the resolution of the geological/ archaeological record may simply be to coarse grained to resolve this).

In the final analysis it seems clear that Neanderthals were highly dependent on stone tools for their survival. This is reflected not only in sophistication of manufacture but in strategies for transporting and maintaining artifacts in service of a mobile lifestyle. Yet their artifacts were largely instruments for gaining a mechanical advantage in the world. Neanderthals' tools did their work as interfaces with the physical and biotic environments. They had not taken the final step of recruiting technology into social and symbolic realms.

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Symposium 4: Neanderthal Anatomy, Adaptation, Physical and Cultural Variations

Conveners: SILVANA CONDEMI & WINFRIED HENKE

Respondent: PATRICIA SMITH

After 150 years studying of Neanderthals, what do we really know about them? Which of their anatomical traits permit us to recognize and define them? What do we know about their growth and development? Do their morphological features result from adaptation to the particular climate of the middle Pleistocene? Does the Neanderthal pattern indicate long-term isolation in Europe or even speciation? The Neanderthals inhabited a vast geographic area extending from Portugal to Uzbekistan, and from northern Europe to the Near East. This raises the question concerning the homogeneity of the Neanderthal population. Is it possible to identify local variations in such a large areas? Can one recognize sub-groups?

Neandertal as another humankind: where are we now?

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A century and a half of investigation in Europe and in the Middle East has resulted in the collection of a large sample, allowing us to study many aspects of the biology and behaviour of the Neandertals. One main interest of this late Middle-early Upper Pleistocene fossil hominin group results from its peculiar situation in the hominin phylogenetic tree. It likely represents our sister species, i.e. the last diverging branch before the emergence of modern humans. Because of this proximity, assessing the anatomical differences between the two groups and their evolutionary significance has provided ground for discussions about how to define fossil species within the Pleistocene hominins.

During the twentieth century, the possibility of an ancestor-to-descendant relationship between the two groups was rejected by many scholars, especially in Europe. The “Wurmian Neandertals” were too close in time and too different to be ancestral to the modern Europeans (e.g. Piveteau, 1957). Among these authors, disagreements centred primarily upon the timing of the separation between the two groups. For the supporters of the “pre-sapiens model”, best expressed by Vallois (Boule and Vallois, 1952; Vallois, 1958), the modern human ancestors had long existed in Europe or in Asia and eventually replaced the Neandertals. For the supporters of the “pre-Neandertal model” such as Sergi (1953), the features of the two groups were present in variable proportions in the European and Near-Eastern fossil record until the last interglacial, and the separation occurred only later. Authors such as Le Gros Clark (1955) and Howell (1957) did not express very divergent views. Alternatively, scholars such as A. Hrdlicka (1927) and F. Weidenreich (1947), later followed by L. Brace (1964), supported a direct ancestral relationship between the Neandertals and the modern Europeans. Following a somewhat different line of thought, the views of Weidenreich according to which modern “races” were rooted, in the form of identifiable regional lineages, in this stage and even before, flourished with the works by C. Coon (1962) and other supporters of the “regional continuity” model Wolpoff *et al.* (1984). During the same period, a re-examination of the European and Near Eastern fossil evidence occurred. This led to a much clearer definition of Neandertal morphology (Stringer, 1974; Hublin, 1978; Santa Luca, 1978; Trinkaus, 1981, 1983) and confirmed the diverging nature of the Neandertal lineage from the middle of the Middle Pleistocene Hublin (Hublin, 1980; 1988a,b). These analyses, mostly influenced by cladism, have led us to propose an “accretion model” (Hublin, 1998), which argues that most of the Neandertal morphology was established in the late Middle Pleistocene, on specimens as old as Isotopic Stage 7 such as Biache (Rougier, 2003). This establishment results from an increase in the frequency of features mostly already present in the spectrum of variability of the earlier Middle Pleistocene European hominids. When considering the African lineage leading to modern origins, similar questions arise. Some authors (Braüer, 1984) have proposed a model of gradual emergence of the *Homo sapiens* phenotype through an accretion process quite comparable to what we proposed for the Neandertal lineage. Alternatively, it is possible that a different process would have resulted into a speciation event resulting in the emergence of *Homo sapiens* 160-180 ky ago in Africa. To date, the scarcity of the material as well as the uncertainties surrounding the ages of many specimens leaves this question open. It is difficult, however, to draw a clear-cut line between “fully modern” and “archaic” morphologies.

Features' Significance

A continuing discussion addresses what can be seen as plesiomorphic retentions or derived features in Neandertals and modern humans. Although Neandertals do display some derived conditions and possibly unique features, some have argued (Trinkaus, in press) that they display more primitive conditions than do late modern humans. Similarities in some aspects of the Neandertal morphology with the pattern observed in the common ancestors of Neandertals and modern humans, together with the distinct morphological distance observed between Neandertals and modern humans, actually reinforce the notion that *Homo sapiens* is a recently developed species. Isolating and defining morphological features was central in the re-examination of the Neandertal anatomy, in particular, in a cladistic perspective.

It is also central to the problem of assessing the morphological distance that exists between Neandertals and modern humans, and how this compares with the modern variability and the morphological distance observed between species or subspecies of extant primates. One must say that this issue is far from being resolved, and it has led to a number of discussions (e.g., Trinkaus, 1990; Lieberman, 1995). When anatomical features are divided into sufficiently discrete elements, in most cases it is possible to sustain the view that these "features" are observed in both Neandertals and modern humans, but with different frequencies. In reality, the biological significance and validity of these features as independent traits, and often, their complete homology, are questionable. It remains that for virtually all single metric features used in osteological analyses, there is some overlap between Neandertals and modern humans. However, when combinations of metric or non-metric "features" are taken into consideration, a different picture emerges and the two groups appear to be quite distinct (Hublin, 1988a; Bailey, 2002; Harvati et al., 2004).

One main problem comes from the lack of understanding of the determining factors underlying many of the "features" used. Most cranio-mandibular and postcranial features are unclear in terms of evolutionary emergence (adaptation *versus* random drift), development (genetic *versus* epigenetic determinism) and independence. The development of these "features" depends partially on both behavioural and environmental factors during individual growth. In particular, this means that if significant behavioural changes occurred with the last Neandertals or with early modern humans, it might be difficult to discriminate between results of gene flow and the results of these behavioural changes (Hublin and Bailey, in press). It is, however, also to be noted that in some cases we are dealing with nonplastic features which are therefore primarily determined by the genome and unlikely to be submitted to very significant behavioural or environmental influences. This is true for the morphology of the inner ear (Hublin et al., 1996; Spoor et al., 2003) and for dental non-metric traits (Bailey, 2002). Both of these are at least partly fixed before birth and display clear distinction between Neandertals and modern humans. Similarly, Ponce de León and Zollikofer (2001) have recognized that cranio-mandibular differences between Neandertals and modern humans are established following parallel but distinct growth trajectories.

Finally, another difficulty arises from the fact there is a certain level of integration of development within anatomical units, and that the definition of "independent features" can be quite problematic. However, in phylogenetic analysis, morphology is routinely split into elementary traits. As already stated, when combinations of features are used, for example as in 3D morphometrics analysis (Harvati, *et al.,* 2004) or in analysis of nonmetric dental features (Bailey, 2002), Neandertals and modern humans unquestionably represent discrete morphological entities. Evidence for integration several aspects of the posterior portion of the brain case have been recently established by Gunz and Harvati (submitted).

Selection *versus* Drift

In the palaeoanthropological literature, adaptation by way of selection is implicity considered the main phenomenon driving hominin evolution. However, direct evidence of this process is rarely provided when dealing with specific features routinely used in phylogenetic and taxonomic analyses. There is little doubt that features such as the body proportions in Neandertals might result from a climatic adaptation to the middle latitudes with and environment that was, most of the time, colder than in present-day conditions (Trinkaus, 1981; Holliday, 1997). However, similar interpretations regarding, for example, face pneumatisation or nasal morphology failed to be demonstrated (Franciscus, 1999). In the accretion model as we proposed it in 1998, a major role is assigned to genetic drift in relation with distance and isolation. We have argued that this drift was partially driven by environmental changes, namely the "Middle Pleistocene Revolution" (Helmke *et al.*, 2003). Changes in the periodicity and amplitude of the swing between glacial and temperate episodes resulted, for Western Eurasian populations, in periodic increases in isolation relative to Africa, and also in periodic demographic crashes. Under these conditions, non-metrical features such as those observed in the Neandertal cranial vault (Hublin, 1998) or dentition (Bailey, 2002) would have been fixed by chance, and their frequency would have increased without any significant selective pressure. It must be said that the adaptive advantage represented by the development of a suprainiac fossa on the occipital or a transverse trigonid crest on the lower molars is far from being obvious, unless we assume that these features are connected, by pleiotropic effects, to some unknown biological feature of great adaptive value. In support of this view is the fact that mitochondrial DNA variation within Neandertals is on the same order of magnitude as that observed in large modern groups of populations, and well below what is observed in great apes (Gagneux et al., 1999; Serre et al., 2004). For most geneticists, this would presumably result from the occurrence of bottlenecking events in humans (Neandertals or modern), contrasting with a more stable demographic history for the direct ancestors of extant hominoids. Recent work by Roseman and Weaver (2004) and Harvati and Weaver (in press) as suggested that cranial morphological features commonly used to assess the phylogenetic status of Pleistocene hominids vary in modern human populations in direct relation with genetic distance, and only in some instances with environmental parameters. In addressing more directly the issue of Neandertal/modern human divergence, Weaver *et al.* (submitted) have shown, by applying a series of statistical tests, that the emergence of Neandertal and modern cranial morphologies is likely related to random genetic drift. In particular, they have underlined how cranial linear measurements can compare to the neutral evolution of genetic structures such as microsatellites.

Taxonomic Status

Supposing that Neandertals and modern humans were rodents or antelopes, no vertebrate palaeontologist would hesitate in assigning them to different paleontological species. Indeed, they are humans that shared very similar technical and behavioural adaptations. In the past, this, among other things, has led many anthropologists to incorporate them into the same species as ourselves. In part, this is a product of anthropologists' characterization of humans as a unique entity characterized by Culture. In some extreme examples (Wolpoff and Caspari, 1996), all hominids post-dating 2 million years BP are incorporated into the species *Homo sapiens*, which is seen as a chronospatial network of populations connected by gene flow, and subject to the same general adaptive trends.

Neandertals identified as a late Middle and early Upper Pleistocene western Eurasian group of hominins are quite different from modern humans. In terms of shape distance, Neandertals and late Pleistocene modern humans are at least as different as some closely related species of apes, such as bonobos and chimpanzees (Harvati *et al.*, 2004).

Whether these clear phenotypic and developmental differences imply that Neandertals and modern humans represented totally isolated biological species and/or whether or not there could have been some hybridization or gene flow between the two groups is a separate issue. In nature, there are abundant examples of hybridization between closely related extant species, including the production of fertile hybrid populations (Holliday, in press). From a morphological point of view and in a paleontological perspective, it makes sense to use different specific denominations for the two groups, i.e. *Homo neanderthalensis* and *Homo sapiens*, and these concepts are fully operational for the terminal portion of the two lineages. The separation is, of course, less clear-cut when moving back in time, closer to the splitting point between the two lineages. This situation is nothing new in palaeontology.

To date, more than fifteen Neandertal remains have provided mitochondrial sequences, among which ten or so have been published (Krings, et al., 1997; Ovchinnikov et al., 2000; Serre, et al., 2004; Lalueza-Fox et al., 2005). Specific motifs in the basic sequences are found systematically in these fossils and remain unknown in extant humans and in any fossil specimen demonstrable non-Neandertal. Unfortunately, mitochondrial DNA does not provide us with any kind of yardstick with which to address the issue of species definition and tells us more about relationships and time of divergence between lineages as well about their demographic history. Several attempts of modelling based on the palaeogenetic data have been made in order to assess the possibility of interbreeding between Neandertals and modern humans at the beginning of the Upper Palaeolithic in Europe. Modelling based on very conservative and simple assumptions by Serre *et al.* (2004) initially suggested that gene flow between Neandertals and modern humans could not be rejected based on the limited number of specimens available at the time of their analysis. However, even then, Neandertal genetic participation in the modern European gene pool could not have exceeded 25% without being visible. More recently, Currat and Excoffier (2004) refined the model taking into account the fact that the invasion of Europe by modern humans would result in the establishment of a moving front of potential hybridization. Their analysis of the data concludes a maximum introgretion of Neandertal genes into the modern European gene pools at a level of 0.1%.

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Paleoauxology applied to Neandertals

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The fossil record from Europe document morphology and ontogenetic patterns in Neandertals and is essential for addressing the question of distinctive growth pattern relative to modern humans. Evolutionary studies of skeletal remains demonstrate that bone preservation and sampling limitations magnify the difficulties in the reconstruction of the skeletal biology of immature Neandertals. Non-adult individuals represent no more than 25% of the overall Neandertal sample, and given the preservation of the fossil record, some skeletal growth stages are less well documented than others. The specimens employed to document distinct developmental stages within the entire Neandertal population originated from sites often separated by hundred (or thousands) of kilometres and thousands years in time. Only a few European sites have a large enough sample size to evaluate individual variation or to permit a comparison between non-adult and adult skeletal morphologies within a single sample. Geographical and temporal variations, as well as lack of data, should not be neglected in the analysis of the fossil record and the reconstruction of maturation patterns.

Recent modern human samples used in comparative analyses are mostly originating from regional collections (some of them used in forensic medicine studies). Reference modern standards (*e.g.* enamel microstructure growth components, tooth calcification and erupting sequence, limb proportions, body size) may or may not be appropriate for the specimens under investigation. Examinations limited to individuals belonging to sedentarized and/or industrialised populations are, indeed, inadequate to define the contrasts in skeletal robusticity between Neandertal and early modern children, or to discuss evidence of differences in muscularity or limb proportions. From an auxological perspective, it is clear, for instance, that the investigation of post-cranial development in immature Neandertals will benefit from an enlarged sample that will document the diversity of sub-adult modern skeletal morphology within past (i.e. Middle and Upper Paleolithic specimens) and recent populations.

This contribution attempts to address few aspects of the ongoing debate over the presence or absence of differences in growth and development patterns between Neandertals and early modern humans. The deficiency of well preserved skeletons which is a common problem for growth-related research limits the evaluation of individual variation. In addition it is difficult to appreciate the importance of sexual dimorphism in the manifestation of morphological variation during the growth period. Skeletal data are assembled from infants and children who were the non-survivors in the population, a common situation in the study of archaeological samples and such data are nevertheless employed to reconstruct growth patterns and maturational events within the neandertal lineage.

However, comparative analyses provide accurate information regarding the ontogenetic appearance of several diagnostic neandertal characteristics in the skull and post-cranial skeleton. Such studies reveal similarities and contrasts between Neandertal and early modern children, but additional studies are necessary to interpret morphological differences as reflections of temporal and/or regional changes. Investigation of within-site variation in growth related features would benefit from the accumulation of data with further studies and new discoveries.

In 2006 we are still far from a consensus on the nature of the patterns and biological processes that contributed to the development of the Neandertal skeletal morphology. Nevertheless it is obvious that many paleoanthropologists will undoubtedly continue to search for dental and skeletal criteria supporting differences in growth rate and maturation events between Neandertal and modern children.

Computerized Reconstruction of Prenatal Growth Trajectories in the Dentition: Implications for the Taxonomic Status of Neandertals

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Over 150 years after their first discovery, there is still no consensus concerning the taxonomic status and fate of the Neandertals. Hydlička's complaint (1930:319), that Neandertal skeletal remains are too few and too incompletely preserved to provide adequate population samples of both sexes for in depth analysis using standard morphometric criteria is still valid, as is his contention that the Neandertal debate warrants continued evaluation as new sources of evidence become available. However, despite progress in the application of aDNA techniques to examine the status of Neandertals, there is still no consensus regarding the results so far obtained (Gutiérrez et al. 2002; Pääbo et al. 2004).

One new direction for research is the application of current theories linking the timing and pattern of developmental variation to evolutionary diversity. Lieberman (2002) has recently reviewed the limitations of this approach for interpreting skeletal growth in fossil hominids. However, the dentition provides a more reliable source of comparative data because of the hierarchical sequence of tooth development. This approach stems from the understanding that the precise timing and conservative pattern of tooth formation means that the contribution of successive phases in development to final tooth form can be identified from the topography of the dentin enamel junction (DEJ) and outer enamel surface (OES). This permits identification in any one individual of the source of developmental variation expressed in crown morphology. The concept is not new (see for example Kraus 1952; Korenhof 1982; Sasaki and Kanazawa 2000), but it is only recently that advances in imaging techniques have made possible the application of CT scans to provide accurate computerized 3D reconstructions of individual teeth. This approach was pioneered by Smith et al. 1997, 2000 using an Elscint scanner, but has been vastly improved by the introduction of the desktop scanner, that permits scans 16microns apart as opposed to the 1mm previously achieved (Avishai et al. 2004). Since biomineralization marks the end of cell proliferation and begins at the interphase between enamel and dentin, the topography of the DEJ boundary preserves the pattern of and extent of cell proliferation within the tooth germ, while comparison between this and the OES provides evidence of the relationship between crown morphology and underlying ontogeny

Using this approach we have scanned some 30 lower molars of recent humans. that differ in size, tooth class and stages of development. Since the order of cusp initiation in the mammalian molar is constant, we used the cusp tips of the protoconid, metaconid and hypoconid, which are the first cusps initiated, as our reference plane for evaluating subsequent development (Butler 1967). Computerized reconstructions of each tooth were compiled using a special algorithm and applied to calculate the spatial relationships and volume of each cusp at the DEJ and OES respectively. Analyses included: locating enamel and dentin cusp tips, defining coalescence points of each cusp with adjacent cusps, calculating cross-sectional area and thickness of enamel at standard points along the cusps, calculating cusp and crown volume and maximum perimeter and area of the crown as well as distances derived from point measurements - dentin and enamel cusp and crown heights, differences in heights of coalescence and inter-cusp distances (Figure 1).

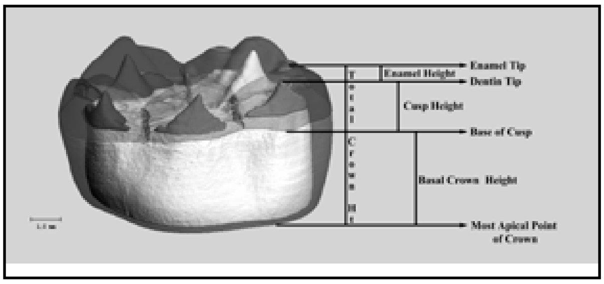

Figure 1. Three dimensional reconstruction of tooth, showing measurement points for enamel and dentin.

The vertical distance between cusp tips was used to estimate the order of cusp initiation and the distance between the most occlusal and most apical points of coalescence of the cusps, defined as Maximal Fusion Height (MFH), was used to assess the order of coalescence events and the amount of growth between them.

Comparison of cusp height and volume defined by the DEJ showed that the amount of growth occurring between successive initiation events varied between teeth and between tooth classes, but that the same order was maintained in all teeth - protoconid, metaconid, hypoconid, entoconid and hypoconulid. However, we found that the order of coalescence differed from that of initiation, with the hypoconulid, the last cusp to begin development, completing coalescence before the metaconid. Although the metaconid was the second cusp to begin development and fused early with the protoconid, it continued growing on its distal and inner slopes until finally coalescing with the entoconid (Figure 2). In all tooth classes the hypoconid and hypoconulid were the two shortest cusps at the DEJ.

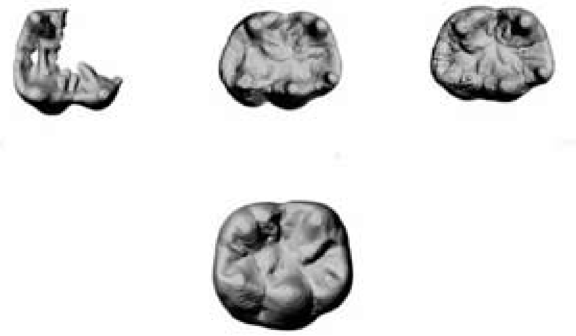

Figure 2. Successive stages of tooth development. Note the prominence of the mid-trigonid crest in the early stages of development.

Our results showed that tooth size was most highly correlated with size of the metaconid and entoconid. Although these are characterized as thinner and more pointed than the buccal cusps, their greater height was accompanied by increased basal area and reflected in their larger volume relative to other cusps. This also contributed to increased buccolingual crown breadth and distal displacement of the entoconid and attached hypoconulid. It was also reflected in the depth of fissures and fovea - the greater the disparity in amount of growth before coalescence between cusps, the greater the disparity in height and size of the anterior and posterior fovea and central fossa.

Differences were found in the thickness of the enamel shell on the surface of each cusp so that the topography seen at the OES was much smoother and flatter than that at the DEJ (Figure 3), like the covering of snow that smoothes out jagged mountain peaks and fills in crevices. Enamel on the outer surface of all cusps was thicker than that on the inner slopes. Enamel on the lingual cusps was thinner than on the buccal cusps and enamel thickness increased in the distal cusps. Enamel thickness was not however correlated with cusp size. Indeed it was negatively correlated with the height of the hypoconulid, suggesting if anything some compensatory increase to maintain occlusal form, since it increased in thickness in the smallest teeth.

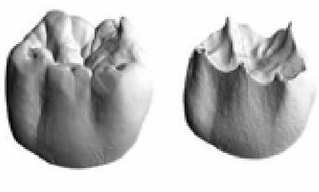

Figure 3. Computerized reconstructions of the dentin and enamel surfaces of the same tooth. Note the rounded contours of cusps on the enamel surface relative to that of dentin.

Finally, when the spatial components of growth expressed by the Euclidean distances between cusp tips were broken down into their horizontal and vertical vectors, we found major differences between tooth classes. In the fast growing deciduous molars, both horizontal and vertical vectors were of similar length, reflecting continued growth of the tooth bud in length and breadth as well as height, between the initiation of successive cusps. Similarly, even after cuspal coalescence rapid proliferation at the base of the united cusps continued, vastly increasing the maximum contour of the crown but was followed by a marked constriction towards the neck of the tooth. This resulted in a bulbous outline to the crown. In the permanent molars we found that vertical vectors of growth in cusps were small relative to horizontal vectors. Thus our model shows that the size of the permanent teeth appears to be almost fully determined before the advent of biomineralization. This is corroborated by comparison of intercusp area which is much larger relative to maximum crown contour in the permanent as opposed to the deciduous teeth.

Molar dental traits identified as characteristically Neandertal include thin occlusal enamel, small occlusal area relative to maximum contour of the crown, lack of cervical constriction, taurodontism and large anterior fovea with mid-trigonid crests.

Our computerized model indicates marked differences between Neandertal and modern human molars throughout all stages of molar development. The discrepancy between the relatively small occlusal area and maximum crown contour seen in Neandertal permanent molars indicates that differentiation of cusps in these teeth, begins relatively early in a rapidly proliferating tooth germ. The retention of details expressed prominently at the DEJ, such as deep fovea and mid-trigonid cusps, supports the hypothesis of thin, more evenly distributed cuspal enamel. While these features recall the characteristic pattern of development of modern deciduous molars, later stages of development of Neandertal molars, differ markedly. Since they tend to lack clear differentiation of crown and root outline. Instead the pulp cavity is frequently continued into a common root trunk, producing radicular taurodontism. This unique pattern of development is not found in archaic *Homo* from the Levant that pre-date many Classic Neandertals. Neither has it yet been identified in more recent specimens classified as *Homo sapiens sapiens*. At this stage of research, the findings from our computerised model, suggest that dental development in the Neandertals deviated from that of earlier and later populations of *Homo,* so that the most parsimonious hypothesis is that they represent a distinct species.

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Neanderthals, Energetics and Evolution

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Since their initial discovery and recognition, the Neanderthals have held a unique fascination. They are so close to modern humans in date but yet are characterized by a distinct morphology that raises interesting questions about taxonomic and phylogenetic relatedness as well as about lifestyle adaptations. Questions of taxonomic and phylogenetic relatedness have been dominated by the Out-of-Africa versus Multiregional hypotheses for the origin of modern humans and their more recent variants. Originally based on morphological arguments, these issues have more recently, and very fruitfully, been addressed through genetic methodologies.

Questions of lifestyle adaptations have also traditionally been largely addressed through morphological analyses. Recent work has involved innovative analyses leading to hypotheses about growth and development (e.g. Pettitt 2000) and other life history variables (e.g. Caspari and Lee 2004, 2006) along with work on masticatory biomechanics (Rak and Hylander 2003) and upper limb asymmetry (Schmitt et al. 2003). However much of the morphological work on Neanderthals has focused on features that are best explained in the context of adaptation to the glacial climatic conditions that prevailed during the majority of the time since they first emerged as a recognizable species approximately 250 ka BP. These features include the long Neanderthal head (Steegmann and Planter 1968), large noses, large paranasal sinuses and big brains (Churchill 1998) along with a suite of postcranial features that are consistent with the cold weather predictions of Bergmann's and Allen's Rules (e.g. Trinkaus 1981, Trinkaus and Ruff, 1989, Ruff 1993, 1994, Holliday 1997a,b, Churchill 1998, Franciscus and Churchill 2002,). These features include a relatively short and stocky body characterized by large rib-cages and barrel-shaped chests, very wide trunks, short legs and relatively short distal extremities.

In recent years a number of researchers have been attempting to go beyond basic lifestyle inferences from morphology and look at Neanderthal adaptation from the point of view of energetic expenditure (Sorensen and Leonard 2001, Steegmann et al. 2002, Steudel-Numbers and Tilkens 2004, Aiello and Wheeler 2003, Churchill 2006). There is a growing consensus from this work that Neanderthals had an exceptionally high-energy budgets and that these high-energy budgets were a major factor in their ultimate disappearance. The purpose of this contribution is to assess the evidence for this hypothesis.

Inferences in relation to Neanderthal energetic expenditure come from two major areas. The first of these is foraging efficiency including locomotor adaptation and the second is climatic adaptation. In relation to foraging efficiency, Sorensen and Leonard (2001) have estimated an average daily energy requirement of Neanderthals ranging from 3000-5500 kcal/day. This is based on the relatively high Neanderthal body mass together with levels of physical activity two to three times basal metabolic rate (BMR), levels consistent with those found in modern foraging populations. The main point being made by these authors is that Neanderthals must have been efficient foragers to supply this level of energy requirement. Although the Neanderthal skeletal robusticity has been interpreted to indicate high activity levels compared to modern humans, contrary to some earlier interpretations (e.g. Trinkaus 1986), this high activity level does not indicate inefficiency in foraging. Their point is that Neanderthals had elevated energy demands and could not have survived without being efficient foragers to satisfy these elevated energy demands.

Sorensen and Leonard (2001) base their estimates on comparisons with modern human foraging populations corrected for the increased Neanderthal body mass. The same is true of Steegmann et al. (2002) who arrive at similar conclusions in relation to Neanderthal energetic demands based on contemporary data from circumpolar peoples. The assumption in both of these analyses is that modern humans are reasonable analogs for Neanderthals. This assumption may not be correct. Steudel-Numbers and Tilkens (2004) provide interesting evidence that the relative length of the leg has an important effect on locomotor energetics and conclude that the combination of the relatively high Neanderthal body mass and relatively short Neanderthal legs would result in locomotor costs that are 30% greater than those of modern humans. This might be expected to substantially increase the average daily Neanderthal energy requirement estimated by Sorensen and Leonard (2001) and Steegman et al (2002) based on modern human energy requirements. It further underscores the high Neanderthal energy demands and the necessity for foraging efficiency.

A relatively high total energy expenditure, consistent with the inferences of Sorensen and Leonard (2001), Steegman et al. (2002) and Streudel-Numbers and Tilkens (2004) would also be essential for Neanderthal climate adaptation. Until recently (Steegman et al. 2002, Aiello and Wheeler 2003, Churchill 2006) there has been little attention to Neanderthal thermoregulation other than the implication that because Neanderthals have morphological features that are consistent with cold weather adaptation they could have easily survived under glacial conditions. However, to the contrary Steegman and colleagues (2002) emphasize that although the Neanderthal body form may have contributed to Neanderthal cold defense, they also undoubtedly relied on a variety of other defenses such as high-energy metabolic adaptation and thermogenic brown adipose tissue.

Aiello and Wheeler (2003) test the assumption that Neanderthal body form and particularly the surface area/volume ratio do contribute to Neanderthal cold defense and conclude that it gives only scant thermoregulatory advantage in relation to modern humans. Their analyses are based on estimates of basal metabolic rate (BMR), skin surface area, thermal conductance and the maximum sustainable elevation in resting metabolic rate. Results show that a naked Neanderthal with a BMR predicted by the Kleiber body mass/metabolic rate equation (Kleiber 1961) would need to initiate additional heat production (thermoregulatory thermogenesis) at 27.3°C (81.2°F) while modern humans would initiate thermogenesis at 28.2°C (82.7°F) (Aiello and Wheeler 2003). At a maximum metabolic rate of three times BMR that can be sustained indefinitely by a modern human (Burton and Edholm 1955) the minimum sustainable ambient temperature for Neanderthals would be 8.0°C (46.5°F) and for modern humans 10.5°C (50.9°F) (Figure 1). These temperatures are considerably above the inferred median winter ambient temperature (wind chill) of 3.1°F for 41 European Mousterian sites spanning the period 37-22 ka BP (Aiello and Wheeler 2003 Table 9.8).

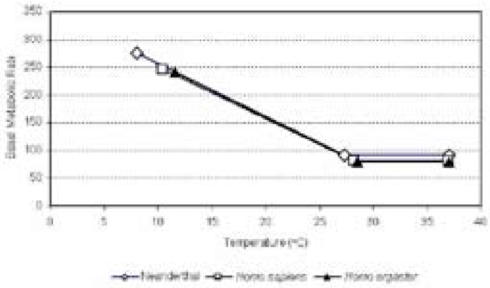

Figure 1. The lower critical temperatures when thermoregulatory thermogenesis must begin and the minimum sustainable ambient temperatures at three times BMR for Neanderthals, *Homo sapiens* and *Homo erectus* (data and equations from Aiello and Wheeler 2003).

These analyses are based on the assumption that Neanderthal BMR and thermal conductance were identical to those of modern humans. There is reason to believe that this might not be a correct assumption. Modern arctic adapted people have significantly higher BMRs than people adapted to the tropics. This elevated BMR is derived from two sources, a diet based on high intake of animal fat and protein and the effects of temperature and day length on thyroid function (Leonard et al. 2002). Neanderthals were also heavily muscled and this would have had a significant effect on the conductance or heat loss from the surface of the body. When the basic assumptions of the model are altered to accommodate a higher Neanderthal BMR together with a lower conductance, Neanderthals would need to initiate thermoregulatory thermogenesis at 25.3°C (77.6°F) and their minimum sustainable ambient temperature would be 1.9°C (35.5°F). These temperatures are still considerably above the predicted median worst-case glacial winter temperatures (3.1°F) that Neanderthals would have experienced.

The conclusion is that Neanderthals could not have survived the glacial conditions solely through their cold weather adapted body form or relatively high metabolic rate, even with the variety of defenses outlined by Steegman and colleagues (2002) which would have most probably included among others at least a modest reliance on thermogenic brown adipose tissue and general mammalian cold defenses such as systemic vasoconstriction together with acclimatization, aerobic fitness and localized cold-induces vasodilatation.

Significant improvements in Neanderthal temperature tolerance could only have been achieved through more efficient insulation. If the Neanderthals could achieve additional insulation to the level equivalent to 1 clo they would have been able to survive the worst-case glacial winter temperatures. One clo is the amount of insulation necessary to maintain a resting sitting human whose metabolism is 50 kcal.m-2.hr indefinitely comfortable at 21°C (70°F) and is roughly equivalent to a modern business suit. The Neanderthals could have achieved this level of insulation though a combination of subcutaneous fat, body hair and/ or most probably cultural means such as roughly tailored skins, the use of plant material or even felt. The point is that in the absence of sophisticated insulated clothing a high metabolism with the consequent energy requirements would have been essential for Neanderthal survival. A corollary of this is that the better the insulation the lower the required metabolism for thermogenesis and the lower the energy requirements to support that thermogenesis (Figure 2).

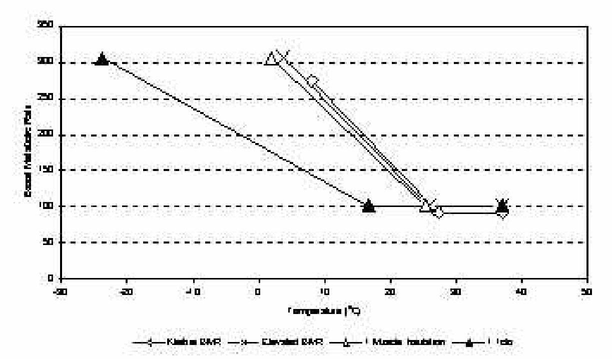

Figure 2. The lower critical temperatures and the minimum sustainable ambient temperatures for a Neanderthal with a Kleiber-estimated BMR, for a Neanderthal with an elevated BMR, for a Neanderthal with an elevated BMR plus a 5% reduction in heat loss as the result of additional muscle insulation, and for a Neanderthal with all of the preceding plus 1 clo of insulation (data and equations from Aiello and Wheeler 2003).

The high-energy requirements implied by all of these analyses may also have had an unexpected influence on Neanderthal body form. In a recent paper Churchill (2006) suggests that the large Neanderthal chest may reflect a high metabolic demand rather than a strictly thermoregulatory adaptation through increasing the surface area volume ratio. Simply stated, the high metabolic demand of the Neanderthals would also require a large lung volume (and hence large tidal volume) to insure sufficient oxygen consumption to support the high metabolism. In so far as the large, wide chest influences total body width, the necessity for a sustained high metabolic rate in the Neanderthals may also be related to the generally wide axial skeleton and the effects of this on other aspects of the anatomy such as femoral morphology (Weaver 2003).

The results of all of this work are in agreement that Neanderthal adaptation would have required a sustained high metabolic rate with the consequent high daily caloric demand to support that high metabolic rate. All of the authors working in this area are in agreement that the high energetic requirements of the Neanderthals were a large factor in their ultimate demise and that their demise may not have had anything to do directly with the deterioration in the climate leading up to the last glacial maximum. Neanderthals had made it though equally difficult climatic events during early glacial periods in the European Middle Pleistocene. The difference this time was the presence of anatomically modern humans in Europe competing for the available resources during the time of deteriorating environmental conditions. The physiological capability of the Neanderthals for survival does not necessarily imply ecological viability (Aiello and Wheeler 2003) and the presence of other humans in Europe could have seriously affected the Neanderthal ability to sustain the required high level of dietary intake (Sorensen and Leonard 2001, Steegman et al. 2002, Aiello and Wheeler 2003, Churchill 2006).

Furthermore, if the modern humans had better insulated clothing their energy requirements would be correspondingly lower giving them a competitive advantage in relation to the Neanderthals. Equally, a greater survivorship among modern humans as implied by the proportions of juvenile in relation to adult fossil remains (Caspari and Lee 2004) would imply larger numbers of modern humans providing them with a competitive edge over the Neanderthals. Likewise a more generalized modern human diet may have resulted in a shorter interbirth interval and more rapid population expansion among the modern humans (Hockett and Haws 2003, 2005). All of these factors, which reflect energy efficiency in modern humans, may have hastened the disappearance of the energetically less efficient Neanderthals. As pointed out by Zubrow (1982) and more recently by Churchill (2006) only a small difference in fertility in relation to the more energy efficient modern humans would have had a profound impact on Neanderthal survival.

There is no doubt that there is much more to learn about hominin energetics and its relationship to the course of hominin evolution, however there is also no doubt that energetics offers a rich and largely unexplored field for human evolutionary studies. A largely untouched area is that of infant and juvenile energetics and this is an area that would be expected to produce rich inferences in relation to Neanderthal adaptation.

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The geographical and chronological variations of the Neanderthals

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The first neanderthal morphological features had been identified on the fossils around 350/400 ky, but their frequency and expression were different from one individual to another, and did not give to the skulls the typical neanderthal shape. These characteristics slowly increased and, in a second stage they combined together accentuating the cranial morphology. At a third stage the typical neanderthal features are more marked resulting in what is called the "typical" or "classical" Neanderthal. Thus, we can distinguish three phases into the evolution of this lineage, but several problems arise from this evolutionary schema. One of them is the very few fossils documenting the first two stages. Another is the inaccuracy of the dates of many of them. The Atapuerca skulls (Sima de los Huesos) have already the general architecture of the Neanderthal ; while the older skull from Arago does not. The age of other fossils, sometimes called "Pre-neanderthals", such as Petralona, is unknown and the Steinheim skull, the morphology of which is related to the first stage, is perhaps more recent. The reality was probably more complicated than this simple schema.

Actually, the fossils assigned to the first phase are often included in a particular species H. heidelbergensis, which would be at the origin of the Neanderthals (H. neanderthalensis). The definition of this species however varies according to the researchers. Thus, for some investigators, it appeared in Europe and Africa at the same time, having being in the latter at the origin of Homo sapiens. For other authors, this species was exclusively European, raising a new question: if the European ancestors of the Neanderthals had already derived characteristics of H. heidelbergensis, it is doubtful whether it is justifiable to make an independent species.

The first part of this paper presents the data and a discussion about the legitimacy of the species H. heidelbergensis.

The "classical" Neanderthals lived during the isotopic stages 5 and 4. They occupied a large territory of about 10.000.000 km2, of 6.000 km west to east, from England to Uzbekistan and of 2.500 km north to south, from the North of Germany to Israel. This vast surface presented a great variety of geographical and climatic areas to which the Neanderthals had to adapt. Under these conditions it is logical to think that these adaptations have produced morphological modifications among the human groups, even if the general architecture stayed the same. To evaluate these differences and to avoid documenting only individual variations, but real population differences, would be ideal to have enough individuals to apply statistics, but this is impossible. However, there are indications which allow us to envisage such variability among populations. The most important differences are between the Near Eastern Neanderthals and the Europeans, possibly, because these two groups are the best represented.

Comparing the Near Eastern Neanderthals with those of Europe, the former have a higher cranial vault, a more rounded occipital, their temporals are different, with more developed mastoids and a higher root of the zygomatic arch.

The Near Eastern Neanderthals, who lived in a more temperate environment, perhaps lost some adaptations to the cold not experienced by their European ancestors. Cranial differences can probably be interpreted in terms of evolution and not of adaptation, because the skulls are more similar to those of "pre-classic" fossils such as Saccopastore, than to their European contemporaries. One of the possible interpretations is that the Near Eastern Neanderthals could have arrived from Europe before the achievement of the classical morphology in that region, and their peculiarities would be the result of an independent evolution. Unfortunately, we do not know the post cranial skeletons of Saccopastore.

Other tenuous data suggest differences among the various Neanderthal populations of Europe; for instance between the "Mediterranean" Neanderthals and those of Western France.

At present, we have onlt very few representative individuals to support the study of the inter- and intra-populational variations. What is known about diversity in the living and recent human populations is in accordance with the idea that the Neanderthals represent a diversified biological group, having evolved throughout time and space under the influence of different microevolutionary factors.

Symposium 5: Neanderthals and Modern Humans

Conveners: GERD-C. WENIGER & JÖRG ORSCHIEDT

Respondent: MILFORD WOLPOFF

The question "what happened during the contact between Neanderthals and early Modern Humans" is an evergreen. For decades there seemed to be a clear cultural borderline between the Middle and Upper Palaeolithic and a clear biological borderline between Neanderthals and early Moderns. Furthermore both borderlines were supposed to fit exactly one onto the other. Today the idea is growing that the situation was much more sophisticated and complex. The session will try to identifying some of the smallest common denominators within the plethora of opinions.

Neandertal Genomics

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A number of techniques have recently been introduced that open up the possibility to perform large-scale genomic analyses from species that became extinct before and during the last Ice Age. We will present direct large-scale DNA sequencing on the 454 platform from DNA extracted from late Pleistocene cave bears, mammoths and Neandertals. By taking advantage of the fact that this technique allows the DNA strand sequenced to be determined, we show that cytosine as well as guanidine residues are affected by modifications that cause nucleotide misincorporations during amplification. When these substitutions are disregarded, there is no evidence for detectable levels of other misincorporations.

Using this technology, we have determined about one million base pairs from the Neandertal genome and analyzed them in conjunction with the human and chimpanzee genomes. We find that Neandertal DNA sequences diverged from those of modern humans in the order of 400,000 years ago. Further analyses are aimed at estimating the size of the population ancestral to modern humans and Neandertals and at adapting this approach to whole-genome sequencing. The prospects of sequencing the entire Neandertal genome will be discussed.

Dating the Transition

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The Middle to Upper Palaeolithic boundary and the first appearance of Anatomically Modern Humans (AMH) in Europe mark an important turning point in human history and cultural evolution. This "transition" is among the most debated issues in palaeoanthropology and Palaeolithic archaeology and has for decades now been the subject of discussion at different levels and on the basis of different lines of evidence.

Two fundamental models have been proposed. Whereas the first argues for a multiregional development of Archaic into Modern Humans across the Old World, the opposed model claims that Modern Humans spread into Eurasia exclusively "Out of Africa" and once there gradually expanded their range into the more peripheral areas. In this model the extinction of the Neanderthals in their last remaining refugia occurred only towards the end of this process.

Over the past several years the hypothesis of a recent African origin for all Modern Humans has been consistently supported by results of genetic analysis of both mitochondrial and nuclear DNA. Independently, genetic studies of Neanderthal remains have revealed fundamental differences between the mtDNA of these hominins and that of Modern Humans and imply a chronologically distant separation of the Neanderthal and Modern

Human lineages. It appears that at least the mtDNA of Neanderthals made, at most, an insignificant contribution to the gene pool of modern *Homo sapiens*.

Models to explain the extinction of Neanderthals and the appearance of Modern Humans in Europe need to take into consideration not only the anthropological determination of hominin fossils but also the interpretation of specific material cultural remains from archaeological sites. In both these fields of research meaningful patterns or models can only be created within a reliable chronological framework defined by highly accurate stratigraphic records and chronometric age determinations. However, it is increasingly clear that the basis for constructing a chronology of the period under consideration (ca. 40.0 - 27.0 ka ^{14}C BP) is flawed and it appears that major contextual and methodological problems have been underestimated. This paper will therefore focus on the evaluation and re-evaluation of both existing and new chronometric records and will address specific problems and recent advances in radiocarbon dating and interpretation.

Sample context and relevance

Sample provenance and choice are among the most important parameters affecting the judgment of quality of dates. The relevance of a sample is often merely assumed, but an uncritical choice of sample can create many problems for the interpretation of ^{14}C dates. The relevance of a date is a function of both the context in which the sample was recovered (secure stratigraphic position) and the association of the sample with human presence / activity. Samples from old excavations in particular have to be treated with caution, due to the frequent absence of stratigraphic control for the large bulk samples necessary for conventional ß-decay radiocarbon dating.

The introduction of AMS ^{14}C dating has improved the situation considerably by providing the possibility of dating much smaller amounts (< 50 mg) of valuable material. This in turn allows for direct dating of single entities / events, with correspondingly better taphonomic and stratigraphic control during sample selection. AMS further enhances the range of sample selection due to the suitability of even the smallest objects. Nevertheless, even with AMS

1) Direct dates on hominid fossils have, in many cases, questionable relevance for the archaeological record.

2) The relevance of direct dates on "significant" cultural proxies (e.g. artefacts such as bone points) for the question of hominid evolution or replacement at the Middle - Upper Palaeolithic boundary is doubtful due to their unknown association with a specific hominin type.

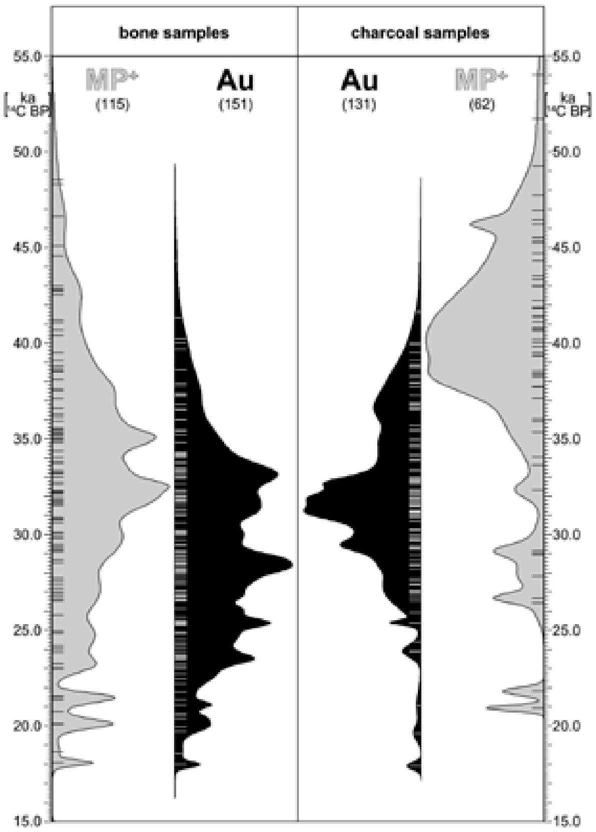

Fig. 1: Age-distributions of radiocarbon samples on bone (left block) and on charcoal (right block) for the European Middle Palaeolithic (MP+), in which we include "transitional", i.e. pre-Aurignacian industries, and the Aurignacian technocomplexes (Au), show different patterns according to the material dated. Judged on the charcoal dates, Middle Palaeolithic and "transitional" industries disappear across all of Europe at around 38.0 ka ^{14}C BP. We believe that the few younger measurements suggesting temporal overlap with the Aurignacian are methodologically unsound for a number of reasons (cf. Jöris et al., 2003).
The majority of charcoal dates for the Aurignacian falls between 34.0 and 29.0 ka ^{14}C BP, with all the dates older than this coming from just the four sites of Temnata Cave (TD-1), Willendorf II (D1), Fumane (A2), and Abric Romaní (2) (cf. Fig. 3). On the evidence of the dated bone samples the temporal overlap between Middle Palaeolithic and "transitional" industries on the one hand and Aurignacian ones on the other would be judged to be significantly longer.
The construction method of the resulting **^{14}**C dispersion graphs defines each individual radiocarbon date by its given median value and standard deviation.
The resulting individual Gaussian curves have been cumulated to give a curve of the summed ^{14}C dating probability.
Data derive from the "Stage Three" database (http://www.esc.cam.ac.uk/oistage3; Davies, 2000). Note that ^{14}C measurements from El Castillo Layer 18 have been removed from the Aurignacian data set and instead included in the MP+ series (cf. Jöris et al., 2003).

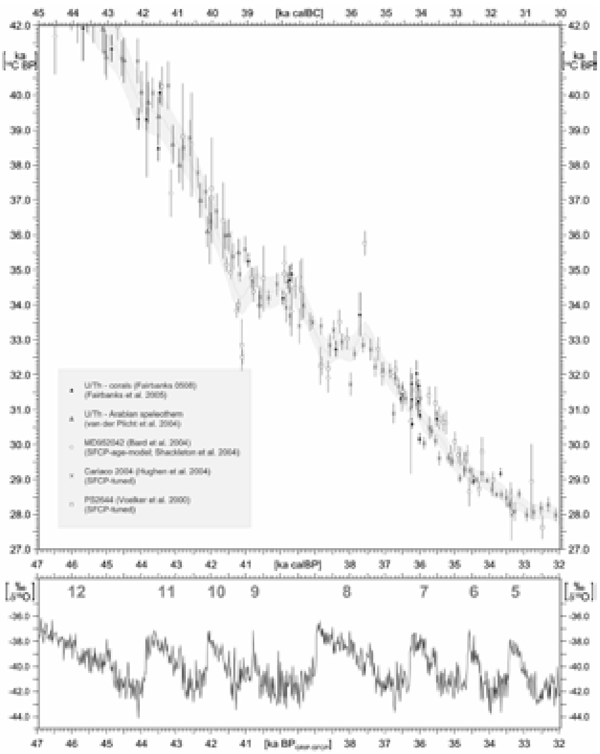

Fig. 2: Radiocarbon calibration records around the Middle - Upper Palaeolithic boundary between 42.0 and 27.0 ka ^{14}C BP are shown against the background of climatic change recorded in the Greenland GRIP ice core ("SFCP-scaled"; cf. Shackleton et al., 2004). Interstadial oscillations are numbered in grey. Over the entire period plotted, the presented datasets show overall agreement with the available paired ^{14}C vs. U/Th data when scaled and tuned to "SFCP" as the common age-model. This allows construction of a synthetic curve for Glacial radiocarbon calibration: CalPal-SFCP-2005 (cf. http://www.calpal.de). The curve indeed contains long plateaux within which massive age distortions will be produced, but other regions of the curve, including the relevant section before 35.0 ka ^{14}C BP are steep and allow precise calibration.

3) Stratigraphic displacement means that direct dates on "associated" material (e.g. cut-marked bone, charcoal) can be misleading for the interpretation of both the archaeological and anthropological records.

Problems of ^{14}C sample contamination and laboratory comparability

The transitional period is close to the limit of ^{14}C dating and we are therefore dealing with an intensification of methodological problems. However, continual improvements in ^{14}C measurement technology and sample pre-treatment have enabled laboratories to produce increasingly older (i.e. probably more accurate) ages for dated samples. In general, dates produced by laboratories with state-of-the-art technology can be regarded with more confidence, in terms of precision and accuracy, than was previously the case.

Due to the small amount of measurable residual ^{14}C, dates beyond an age of 30.0 ka ^{14}C BP have increasingly high standard deviations and do not provide sufficiently fine temporal resolution to answer certain questions.

Due to the magnified effects of even minute amounts of intrusive carbon at the limits of the method we are confronted with an increase in unreliable measurements, the number of which cannot be easily estimated. Sample chemistry becomes increasingly important with sample age, and the sensitivity of different materials to contamination (e.g. charcoal vs. bone) increases disproportionately in the period beyond 30.0 ka ^{14}C BP, whereby bone most often produces younger measurements, a problem which is often underestimated (Fig. 1; cf. Jöris et al., 2003).

Another possible reason for contamination may be the specific location of a sample at a site. For example, bones from Middle Palaeolithic horizons inside the Sesselfelsgrotte rock shelter produced ages in stratigraphical order between 40.0 - 48.0 ka ^{14}C BP, whereas samples from equivalent strata outside the rock shelter drip line gave significantly younger dates, all lying around 34.0 - 37.0 ka ^{14}C BP (Richter, 2004). The samples from the unprotected exterior of the cave are clearly affected by contamination with younger carbon, although it is not at all clear that this is due to intrusive humic acids or other organic substances (Mellars, 2006). An alternative explanation is contamination by inorganic carbon dissolved in percolating groundwater which may have survived standard bone purification procedures[1].

1 We deduce this possibility from results obtained by the Köln radiocarbon laboratory for two bone samples (mammoth, woolly rhino) from the Middle Palaeolithic site of Buhlen. The bones did not give the expected infinite ^{14}C ages (in this case > 46.0 ka ^{14}C BP for the Köln CO_2-ß-counter ZIII), but instead produced young results more fitting for the Neolithic (KN-5103: 5695 ± 50 ^{14}C BP on sample Bu-140-IIIbx[A] and KN-5104: 5550 ± 45 ^{14}C BP on sample Bu-147-Z). Both results are very close to a ^{14}C age of 50% modern, which is hard to explain by the influence of percolating humic acids. Following a suggestion by Peter Becker-Heidmann (pers comm., 2002) we strongly suspect contamination with dolomite ($CaMg(CO_3)_2$). This is a commonly occurring carbonate mineral produced in thermodynamic equilibrium (in the presence of sufficient water for the reaction to proceed) from exactly 50 % atmospheric carbon dioxide and exactly 50 % carbonate. Because both bones (although derived from different strata at Buhlen) have a measured ^{14}C age so close to 50% modern we suspect that dolomite may have been formed within them *in situ* from modern atmospheric CO_2 (with ^{14}C level = 100%) and from the enclosing limestone scree substrate (with ^{14}C level = 0%).

In contrast to bone carbonate, which is readily dissolved in weak hydrochloric acid at room temperature, the Longevin procedure (used routinely for bone-pre-treatment by the majority of conventional and AMS radiocarbon laboratories around the world) would not effectively dissolve dolomite, which only dissociates at elevated temperatures > 80º Celsius. Such acid pre-treatment temperatures are not routinely applied in the preparation of bone samples because they would lead to

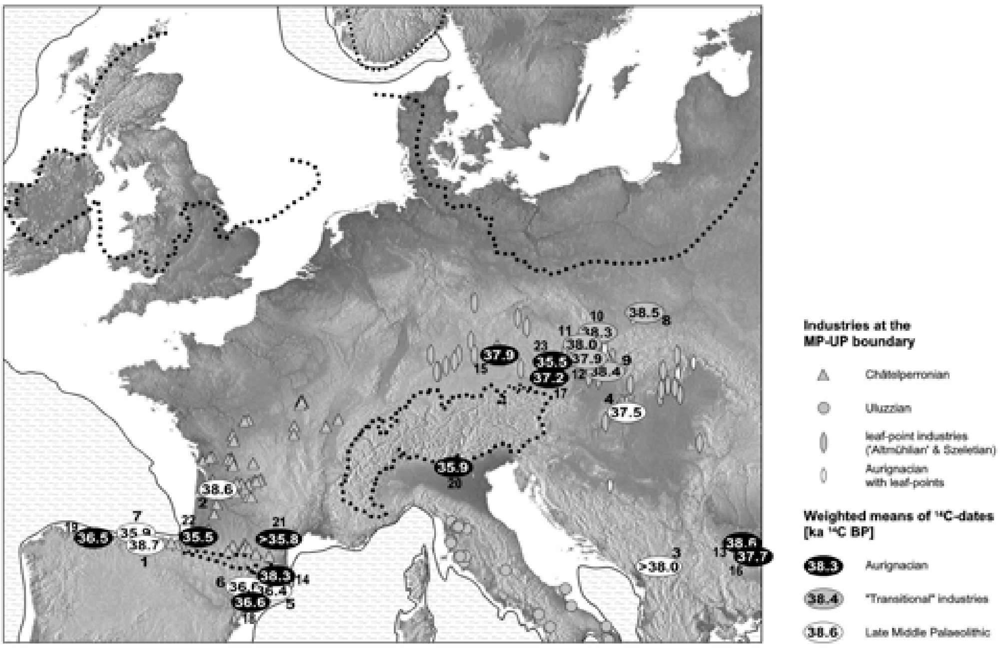

Fig. 3: Europe at the boundary between the late Middle Palaeolithic and the early Upper Palaeolithic, showing occurrences of the "transitional" industries of the Chatelperronian (South-western Europe), the Uluzzian (Italy), the leaf-point industries of southern Central and South-eastern Europe and Aurignacian assemblages with singular leaf-points in Eastern Europe.
Weighted means for radiocarbon dates on charcoal (ka ^{14}C BP) of the late Middle Palaeolithic (white), "transitional" industries (grey) and the Aurignacian (black). Only late Middle Palaeolithic dates < 40.0 ka ^{14}C BP and "transitional" industries and Aurignacian dates > 35.0 ka ^{14}C BP were included (after Jöris, 2004).
Dated sites and layers:
Middle Palaeolithic: 1 El Castillo (18c); 2 Barbas III (4); 3 Smolucka Pecina; 4 Erd (d*); 5 Ermitons (IV); 6 Fuentes San Cristobal; 7 Cueva Morin (10).
"Transitional" industries: 8 Nietoperzowa (Jerzmanovician); 9 Certova Pec (Szeletian); 10 Stranska-skala III (5: Bohunician); 11 Bohunice chihelna (4a-palaeosol: Bohunician); 12 Vedrovice V (Szeletian).
Aurignacian: 13 Temnata Cave (TD-1); 14 L'Arbreda (B1); 15 Keilberg-Kirche; 16 Bacho Kiro (11); 17 Willendorf II (D1); 18 Abric Romaní (2); 19 La Viña (XIII-inf.); 20 Abri Fumane (A2 inner); 21 Grotte Tournal (G); 22 Isturitz; 23 Krems-Hundssteig.

Another problem relates to the comparability of different laboratories. Although inter-laboratory comparisons are routinely carried out, it is rare for a specific archaeological or anthropological specimen to be dated by different laboratories. In consequence the reliability of a result is only exceptionally independently confirmed. In the case of the well known Upper Palaeolithic burials of Sun'gir, dates produced even quite recently by different laboratories (Oxford and Arizona) are statistically not identical and differ by several thousand radiocarbon years (Pettitt & Bader, 2000; Kuzmin et al., 2004). It has been suggested that the discrepancy may be due to differences in sample pre-treatment at the two laboratories (Kuzmin et al., 2004).

Recent developments in the purification of bone collagen are believed to be capable of removing a larger amount of younger contaminant carbon from samples and results for a number of English sites (Jacobi et al., in press) are indeed systematically older than ones for the same bone specimens previously dated without "ultrafiltration" pre-treatment (Bronk Ramsey et al., 2004). Similarly, re-dating of the prominent Vindija G1 Neanderthals following ultrafiltration pre-treatment produced dates significantly older than those previously measured, but which are themselves interpreted as minimum values (Higham et al., 2006).

Radiocarbon data and Glacial ^{14}C-Age conversion

For a better comparability of dates derived from different methods of dating ^{14}C age calibration is required. According to van der Plicht et al. (2004) problems in the synchronization of the different time scales currently in use (e.g. U/Th, limnic varves, marine proxies and various ice core age models) remain unresolved and do not permit an internationally accepted standard ^{14}C

an immediate loss of the bone collagen during acid hydrolysis, while the fumes from the heated acid would be hazardous to the health of laboratory personnel and destructive of the equipment. In conclusion, we believe the dated carbon at Buhlen may have been produced by secondary dolomite contamination. It is conceivable that the secondary deposition of mineral dolomite in bones could also apply in other cases which might provide an explanation for the paradox that ^{14}C ages on Late Middle Palaeolithic and Aurignacian bones are often significantly younger than ^{14}C ages on equivalent charcoal samples (cf. Fig. 1).

calibration curve beyond 26.0 ka cal BP. However, as demonstrated by Shackleton et al. (2004), it is in fact quite possible to transfer highly precise U/Th-ages derived from pristine corals (Fairbanks et al. 2005) via marine synchronisms to a synthetic "Greenland SFCP ice core age model". Following the same procedure we have constructed an extended Glacial ^{14}C calibration curve (CalPal-SFCP-2004). The curve, which was updated in 2005 (CalPal-SFCP-2005; http://www.calpal.de; see Fig. 2), integrates the majority of data sets considered by van der Plicht et al. to be problematical, but is nevertheless internally highly consistent. The majority of these "unresolved discrepancies" (van der Plicht et al., 2004) are immediately explicable and result from the simple fact that the "SFCP age-model" was not applied to them. This is all the more surprising, since the INCAL04 group itself acknowledges the necessity of transferring the marine data to the "SCFP age-model" (Reimer et al., 2004).

Results

In this paper, we suggest that the lack of chronological precision achieved with the radiocarbon method for ages > 30.0 ka ^{14}C BP is less a result of the imprecision of current Glacial ^{14}C calibration data (as contrasted with dendrochronological calibration methods), but is due rather to the far greater contextual, taphonomic and methodological problems presented by ^{14}C dates at the limits of radiocarbon.

After a critical taphonomic and stratigraphic examination of available ^{14}C data, we conclude not only that some individual ^{14}C ages are suspect, but also that this problem applies in varying degrees to the majority of ^{14}C ages beyond ca. 30.0 ka ^{14}C BP. Despite the demonstrated current lack of precision in the radiometric database, it has often been used uncritically or selectively to explain the biological and cultural processes underlying the Middle to Upper Palaeolithic "transition" in Eurasia. Some authors interpret the available radiocarbon database in support of models for a Middle - Upper Palaeolithic transition which propose an extended (> 10.0 cal ka) overlap of Neanderthals and *Homo sapiens*. We however see no radiometric evidence for a large temporal overlap between either Middle - Upper Palaeolithic assemblages or between Neanderthals and *Homo sapiens*, nor do we find convincing evidence for the inter-stratification of Middle and Upper Palaeolithic horizons anywhere in Europe.

Against the presented background of problems and results, the authors suggest that the ongoing re-evaluation and refinement of radiocarbon dating procedures will lead to major revisions of many presently widespread assumptions concerning processes underlying the Middle to Upper Palaeolithic "transition" in Eurasia. We see increasing evidence for the following hypotheses:

With more reliable techniques and methodology, ^{14}C ages for remains of the latest Neanderthals will probably be older than 38.0 ka ^{14}C BP

^{14}C will date the "transitional" industries to between 38.0 - 39.0 ka ^{14}C BP

Although the oldest direct dates on remains of Anatomically Modern Humans at present are no older than ca. 35.0 ka ^{14}C BP (Trinkaus et al., 2003) and ca. 31.0 ka ^{14}C BP (Wild et al., 2005), the species possibly appears in Europe as early as ca. 38.0 ka ^{14}C BP (Higham et al. 2006, 555).

The earliest Aurignacian will date to around ca. 38.0 ka ^{14}C BP

For all of these inferences we recognize the significance of the date of 38.0 ka ^{14}C which translates to a calendric age of approximately 43.0 ka cal BP (Fig. 2).

In our interpretation of the available ^{14}C data, the appearance of *Homo sapiens* was essentially simultaneous across Europe (Fig. 3), within the given limits of dating precision (cf. Jöris et al., 2003; Street et al., in prep.). We can neither confirm a proposed long coexistence of Neanderthals and Anatomically Modern Humans, as has been suggested in the past, nor can we confirm the existence of postulated long-lived geographical borders during the process of *Homo sapiens* expansion (e.g. Vega Toscaňo, 1993; Zilhão, 1993). On current evidence our conclusion is that Neanderthal extinction was an extremely rapid process.

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Late Neandertals & Early Modern Humans: Biology, Behavior and Population Dynamics

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Human paleontological discoveries, direct radiocarbon dating of human remains or of securely associated archeological material, and the adoption of a more dynamic paleogeographical perspective have markedly altered our views of the potential and probable interactions between late Neandertals and early modern humans across Europe. These developments have been associated with a increasing acceptance that typological approaches only stifle insights into human evolutionary dynamics, combined with the recognition that the reproductive barriers surrounding many sibling species (or even sibling genera) are principally behavioral, ecological and/or geographical and rarely biological. This more dynamic approach, in the context of an evolving Late Pleistocene human fossil record, has presented us with the possibility to ask increasingly interesting questions.

The chronological relationships between late Neandertals and early modern humans, in the period principally between 40 and 28 ka BP (all ages in 14C years), have been revolutionized by the increasing application of direct radiocarbon dating to human remains or securely associated archeological remains. However, the chronological refinements continue given that the period in question is near the limits of reliable 14C dating, alternative radiometric dating techniques are rarely applied, and sample preparation techniques continue to evolve. The result is a complex mosaic of both Neandertal disappearance and modern human appearance. There is growing evidence that latest Neandertals in most parts of Europe significantly post-date 40 ka BP, with the latest specimens ca. 39-40 ka BP in Germany (Feldhofer), ca. 38 ka BP in Greece (Lakonis), ca. 36 ka BP in France (St. Césaire), ca. 34 ka BP in the Crimea (Zaskalnaya), <35 ka BP (and probably 32-33 ka BP) in Croatia (Vindija), possibly <36 ka BP in France (Arcy-Renne), and 30-34 ka BP in Iberia south of the Ebro River (e.g., Cabezo Gordo, Zafarraya). At the same time, the only diagnostic modern human remains in Europe >34 ka BP are those from the Peştera cu Oase, Romania (ca. 35 ka BP), and all of the others except for a couple of pieces from Brassempouy are ≤33 ka BP (Cioclovina, Muierii, Mladeč, La Quina Aval, Les Rois). Relevant but more recent are the large Cro-Magnon sample at ca. 28 ka BP, and (given the late survival of Neandertals in the region) the western Iberian Lagar Velho 1 skeleton at 24-25 ka BP. The data are scarce and the absence of specimens is not evidence of the absence of Neandertals or modern humans at any one point in time and space. However, current geographical and chronological data make it difficult to argue for any simple unidirectional replacement of predominantly Neandertal biology by predominantly modern human biology.

In the context of this temporal and spatial mosaic, it is possible to address two related questions. First, how "modern" with the late Neandertals, biobehaviorally? Second, how "archaic" were the early modern humans, biobehaviorally? Given ongoing ambiguities regarding the associations of human biological forms with most Initial Upper Paleolithic (IUP) technocomplexes and with the earlier phases of the Aurignacian, these questions should be answered strictly in biological terms, and only subsequently investigated relative to the behavioral implications of the penecontemporaneous Paleolithic technocomplexes. The outgroups for comparison are, by virtue of their geographical, temporal and morphological parameters and much larger sample sizes, the earlier Middle Paleolithic (MP; OIS 4 and 3) Neandertals and the later Middle Upper Paleolithic / Gravettian (MUP; OIS 3) modern humans, with additional reference to the African and southwest Asian Middle Paleolithic (OIS 6 and 5) earliest modern humans.

Sample sizes for both transitional European groups are small, and more so given the recent cleansing of the early modern human sample of intrusive, more recent, modern humans. However, awaiting further discoveries, these specimens are taken to be representative of their respective groups. This is done even though some of the features in question fall into the ranges of variation of both Neandertals and modern humans despite marked frequency contrasts between the samples.

Late Neandertal Paleobiology

Late Neandertal biology is known principally from the Feldhofer 1 and the St. Césaire 1 partial skeletons, with contributions from the Feldhofer 2, Vindija G1 and Zafarraya specimens. All of them exhibit distinctive Neandertal morphological gestalts, but there are hints of biological and biobehavioral shifts towards modern humans.

In the upper limb, the Feldhofer 1 and 2 and St. Césaire 1 long bones all exhibit the pronounced pectoralis major tuberosity, anteriorly oriented trochlear notch, and/or marked radial curvature dominant among the Neandertals and rare in early modern humans, and the Feldhofer and Vindija G1 remains have the modest deltoid tuberosity, moderate platybrachia and/or medially oriented radial tuberosity more common among Neandertals. However, St. Césaire 1 lacks platybrachia, has a markedly developed deltoid tuberosity, and exhibits a more volar radial tuberosity. In at least the IUP St. Césaire skeleton, there is a clear shift in these relatively plastic upper limb features toward the pattern seen in early modern humans.

These alterations in manipulative anatomy are accompanied by a general decrease in dental dimensions. This dental size reduction is part of an abbreviation in facial size; this facial diminution is especially evident in the St Césaire 1 partial skeleton, since its postcranial dimensions indicate that it must have been a relatively large male. Yet, these changes are not paralleled by a shift in relative anterior dental dimensions, since St. Césaire 1 and Zafarraya 2 retain the proportionately large archaic incisors and canines of earlier Neandertals. Neither one has sufficiently advanced dental attrition to assess their levels of paramasticatory anterior dental use.

In the lower limb, the principal evidence for a shift is in the femoral midshaft. Neandertal femora are characterized by sub-circular midshafts, lacking pilasters, whereas early modern humans generally have pilastric, anteroposteriorly reinforced diaphyses. Some of the difference may be due to their contrast in body proportions, but a substantial percentage of the contrast is due to differential levels of longer distance mobility, all in the context of similar overall levels of robusticity. Among the Neandertals, Feldhofer 1 and the slightly earlier Rochers-de-Villeneuve 1 femora show a shift towards more anteroposterior diaphyseal reinforcement, and this is pronounced in St. Césaire 1. Since these femora are non-pilastric and at least Feldhofer 1 and St. Césaire 1 had Neandertal stocky body proportions, this represents a time-transgressive shift in mobility patterns, in the direction of later modern humans.

Early Modern Human Paleobiology

The early modern human sample prior to 28 ka BP exhibits a suite of characters that are generally considered derived for modern humans, and these fossils therefore are included within that biological group. However, they variably exhibit features that are exceptional for modern humans (even MUP ones), some of which are reminiscent of the Neandertals, some are more generally archaic, and a couple of simply unusual. A couple of others, such as the nasal morphology of Oase 2 and Mladeč 8 (and the later Lagar Velho 1) and the biomechanically inferred body proportions of Mladeč 24 and 27, bespeak relatively recent tropical ancestry, similar to the better documented MUP remains and in agreement with the generally accepted substantial African ancestry for European early modern humans.

The unusual features in this sample, for European early modern humans, are as follows. The distal molars of Oase 1 and 2 (and probably Mladeč 8) are large for Late Pleistocene humans, and they are exceptionally so for the Oase third molars (an archaic feature). Cioclovina 1 exhibits a distinct horizontally oval suprainiac fossa with a medially restricted nuchal torus and no external occipital protuberance (a Neandertal configuration), despite having a modern posterior neurocranium with little occipital bun. Yet, Mladeč 3 and 5 and Muierii 1 (and Cro-Magnon 3) have prominent occipital buns (best known for the Neandertals) but otherwise have distinctly modern external occipital features; other specimens (Cioclovina 1, Oase 2, Mladeč 1 & 2, as well as Cro-Magnon 1 & 2 and Lagar Velho 1) have little or no occipital bun development. The Oase 2 neurocranium has an exceptionally flat frontal sagittal arc, especially in relation to its curved parietal one. The Les Rois 1 and 2 mandibles have marked corporeal robusticity, with a probable planum alveolare in the Le Rois 2 mandible. The Oase 1 mandibular rami, and by inference from it facial shape those of Oase 2, are exceptionally wide. The mandibular foramen of Muierii 2 (as well as those of Lagar Velho 1 and Cro-Magnon 1) is open, but Oase 1 exhibits unilateral lingular bridging of the mandibular foramen (a Neandertal feature). Muierii 2 has a markedly asymmetrical mandibular notch, a common Neandertal pattern but one unknown among Middle Paleolithic or MUP early modern humans. Several of the Les Rois isolated incisors have marked lingual tubercles and shovel-shaped crowns, archaic features lost in the earliest modern humans. The Mladeč 27 femur (as well as the Mladeč 24 humerus), when appropriately scaled biomechanically, indicates a very linear (tropical) body form, but Lagar Velho 1 combines a low (Neandertal-like) crural index with a narrow trunk. And the Mladeč 30 talus has a proportionately large trochlea, similar to Neandertals but also Middle Paleolithic modern humans.

At the same time, there are a few features of early modern humans that may have functional implications. They involve the Muierii 3 scapula and the Mladeč 27 and 28 femora.

The glenoid fossa of the Muierii 3 scapula is narrow, similar to those of most Neandertals (and the few earlier archaic Homo scapulae) and distinct from most MUP scapulae. Functionally, this implies little loading of the glenohumeral articulation in the extremes of medial and lateral rotation, such as would be employed in cocking phase of projectile throwing. It may be more of a general archaic feature, since the broader glenoid fossae are ubiquitous among recent humans. But the functional constraints on the narrow fossa would remain.

The Mladeč 27 and 28 femora are morphologically similar to those of MUP early modern humans in having distinctively pilastric midshafts. Moreover, Mladeč 27 has a large pilaster and pronounced anteroposterior reinforcement, indicating high levels of longer distance mobility. The Mladeč 28 femur, however, lacks the anteroposterior reinforcement and is biomechanically more similar to the Neandertals. Although acceptable within expected ranges of early modern human variation, Mladeč 28 contrasts with the Cro-Magnon femora and most of the MUP early modern human ones.

Issues

These morphological and morphofunctional aspects of late Neandertals and early modern humans in Europe bespeak a complex populational, biological and behavioral dynamic for these "transitional" human populations in Europe. There is no simple shift from one (Neandertal / archaic human) pattern to another (modern human) pattern.

Population Dynamic Issues

From these considerations, it is apparent that the transition to modern humans in Europe followed the populational pattern of early modern humans expanding out of eastern Africa and into Europe post-40 ka BP, variably absorbing regional populations of Neandertals during the subsequent 10 millennia. The different groups, to the extent that they identified themselves as different, saw each other as people, had no objection to positive reproductive encounters, and produced the resultant post-30 ka BP populations. The diverse and variable aspects of the morphological mosaic of European early modern humans cannot be explained otherwise. Further resolution of the populational processes will come only with paleontological samples beyond current expectations, and it is therefore time to set the phylogenetic arguments aside. There are more interesting aspects than the genetic purity of early modern humans in Europe.

Functional Anatomical Issues

The contrasts between the St. Césaire 1 arm remains and those of earlier or contemporaneous Neandertals indicate a shift in the pattern of arm use and loading, perhaps associated with the technological innovations of the Châtelperronian. At the same time, the persistence of an archaic Homo scapular glenoid morphology in Muierii 3 suggests that the widespread presence of bone projective points in the Aurignacian (including the probably contemporaneous Aurignacian of the Peştera Muierii) may not have engendered significantly different loading patterns of the shoulder than were common in the Middle Paleolithic.

In the context of a change in femoral diaphyseal morphology, from a subcircular one to a pilastric one, there is a gradual shift biomechanically (independent of inferred body form or morphological group), from the more generalized loading regime implied by Middle Paleolithic Neandertal femora to the anteroposteriorly focused loading regime implied by the Middle Upper Paleolithic (or Gravettian) human remains. It remains to be seen to what extent the shift to more distance mobility patterns can be documented archeologically through this time period.

Biological Bases of the Skeletal Mosaics

The features of both late Neandertals and early modern humans, the ones that imply behavioral shifts or retentions, are in aspects of the skeleton known to be susceptible to remodeling during development and to variable extents into adulthood. They are therefore potentially plastic and can be used to infer changes in habitual behavioral patterns. Although some of the other features are potentially due to plastic remodeling, they overwhelmingly appear to be due to changes in the genetic bases of their development. However, the actual genetic bases are likely to be multifactorial even in the simplest morphological features, and they will be more complicated in those aspects which are developmentally secondary to other morphological features or are constrained by structural integration in the skull. The genetic bases of all of these morphological features remain beyond current knowledge, and they may remain so for features that are absent or rare in extant humans. Yet, one can begin to hypothesize, or at least to question, what might be the genetic and developmental processes that produced the variable morphological mosaics seen in European (and other) early modern human samples. Such an exercise would transform the debate from one concerned with phylogeny to one addressing the paleobiology of these Late Pleistocene humans.

These issues nonetheless exist in the context of the potential lineal predecessors of the early European modern humans. Those samples include OIS 6 and early OIS 5 earliest modern humans from eastern Africa spreading temporarily into extreme southwest Asia. They include the European and western Asian OIS 4 and 3 Neandertals. And they include the extremely rare early OIS 3 non-Neandertal late archaic or modern humans from north Africa and possibly eastern Asia. Given that the unusual features of European early modern humans include ones that, relative to their predecessors, are Neandertal-like and/or generally archaic, but absent from the earliest modern humans, one can query what the patterns of inheritance of them might be. Were they passed on as discrete traits from one or more of these groups? Were they traits that were genetically present but phenotypically "dormant" in the ancestral samples, and then reemerged through complex processes of recombination? And can we resolve which, and how many, of those potential ancestral groups might have contributed to the resultant perceived mosaic. In all of these considerations, one must bear in mind that these were fully functioning organisms, and not strange chimeras that do not fit our typological perceptions of Neandertals versus modern humans.

Summary

These considerations of late Neandertals and early modern humans highlight the biologically and behaviorally dynamic nature of the perceived OIS 3 transition in Europe. Small samples sizes and limitations in our knowledge of the underlying biology make interpretations of the human paleontological patterns difficult and complex. But current knowledge is sufficient to point towards lines of investigation that will help us to understand, and not merely document, this complex period of European prehistory.

Patterns of cultural variability during the Middle-to-Upper Paleolithic Transition in Europe

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Until the 1980s, the consensus view of the Middle-to-Upper Paleolithic transition (henceforth simply the Transition) was that of an integrated process whereby culturally Middle Paleolithic "paleoanthropian" populations had evolved the biological features universally found among "neoanthropian" humans in tandem with the production of a significant number of cultural innovations. The latter were seen as forming an integrated "Upper Paleolithic package", where blade-based technologies stood as a proxy for the long-distance procurement of raw materials, the emergence of regional traditions of stone-tool making, the specialized hunting of a selective range of prey coupled with a broadening of the subsistence base to include birds and fish, an increase in the number of sites and in the density of archeological levels (suggesting higher population numbers and larger co-resident groups, also manifested in the greater complexity apparent in the layout of residential sites), the manufacture of bone tools, the use of personal ornamentation, and the production of sophisticated figurative art (Brézillon, 1969; Mellars, 1973, White, 1982).

This view was to be challenged in the last quarter of the twentieth-century, largely as a result of developments in human genetics, specifically, the phylogenetic implications derived from patterns of mtDNA suggesting a single, recent African origin for all present day humans (Cann et al. 1987). This evidence would coalesce with two different lines of paleontological arguments pointing to a recent African ancestry for Europe's "neoanthropians"; first, the recognition that their body proportions were typical of tropical populations and formed a marked contrast with those of the continent's "paleoanthropians" (the Neandertals) (Trinkaus, 1981); second, the recognition that the "proto-Cro-Magnon" Skhul/Qafzeh people dated to the last interglacial, and were of broadly the same geological age suggested for the fully "neoanthropian" Omo-Kibish skulls (Vandermeersch, 1981; Valladas et al., 1988).

Together, these developments carried the implication that the biological transition had occurred much earlier in Africa than in Europe, and that the latter's "paleoanthropians" represented a side-branch in the human evolutionary tree, a view that would be boosted by interpretations of the ancient mtDNA extracted from Neandertal fossils by Krings et al. (1997). Over the ten years separating the latter's work from that of Cann et al., no comparable change occurred, however, in the paradigmatic view that the cultural developments subsumed under the expression "Upper Paleolithic" were inextricably inter-woven with changes in brain structure and cognitive capabilities that were part and parcel of the overall process of skeletal neoanthropization. Thus, it was only logical to expect that, in the 1990s, the consensus view of the Transition would have evolved to one that attempted to reconcile the new genetic and paleontological evidence with traditional archeological perceptions of the Middle and the Upper Paleolithic. However, in order to retain the logical consistency of such notions of the Transition as a fully integrated biocultural phenomenon, the geographical scope of the process had to be restricted; it was now proposed that the emergence of overall "modernity" resulted from a speciation event in Africa whence it spread into the rest of the Old World as part of the dispersal of the cognitively superior, anatomically and behaviorally "modern" people generated by that speciation event.

Where Europe was concerned, such a revision of the post-war view of the Transition carried the implication that, by definition, the continent's paleoanthropians could not have been involved in the process: since they were not biologically modern, they couldn't possibly have been behaviorally modern. Moreover, the first uncontroversial manifestations of figurative art in the Upper Paleolithic of the continent were found in the Aurignacian, seemingly in association with the skeletal remains of “neoanthropians”, not “paleoanthropians”; thus, it was only natural to conclude that, in Europe, the story of the Middle to Upper Paleolithic transition was simply that of the extinction without descent of an anatomically and behaviorally archaic species (“Neandertals”) outcompeted by an expanding anatomically and behaviorally modern species (“humans”) (Stringer and Gamble, 1993).

From the beginning, this solution to the reconciliation of the archeological evidence with the largely genetically based “Out-of-Africa-with-complete-replacement” view of modern human origins faced two major problems. First, the fact that, for about 100,000 years, the archeological record of African early modern humans showed little or no evidence of “Upper Paleolithic-ness”. Second, the fact that, as suggested by the Saint-Césaire burial (Lévêque and Vandermeersch, 1980) and the Grotte du Renne’s human remains (Hublin et al., 1996), the Châtelperronian, widely recognized as an Upper Paleolithic entity (Leroi-Gourhan, 1964; Bordes, 1968), had been made by Neandertals. These two facts represented a direct challenge to the paradigmatic view of the Transition as a tightly integrated biocultural process. If the latter was to be retained, satisfactory explanations had to be found for such major anomalies, and these two issues — the origins of “behavioral modernity” in Africa, and the significance of the Châtelperronian — have indeed occupied the center stage of the last ten years of modern human origins research.

Where Africa is concerned, a first attempt at solving the problem was Klein’s suggestion that only after a mutation occurring some time around 50,000 years ago among later African moderns were language and symbolic thinking possible, and that such a mutation would have been the ultimate explanation for the quantum leap in culture and demography triggering the (extraordinarily rapid) expansion across Africa first, and Eurasia after, of the population that carried it (for a recent formulation, cf. Klein, 2003). As pointed by several authors (Lahr and Foley, 1998; Shennan, 2001), this solution was inconsistent with the genetic and archeological data indicating that the out-of-Africa spread of anatomically modern humans had begun well before the temporal horizon postulated by Klein for the occurrence of the putative cognition-related mutation. As a result, an alternative view developed and eventually became predominant: that “behavioral modernity” was gradually acquired in the African lineage leading from populations of the Kabwe “type” to the later Middle Pleistocene “anatomically moderns” (McBrearty and Brooks, 2000).

This view, however, implied a redefinition of “behavioral modernity” that reconciled it with the archeological record of the African Middle Stone Age, in particular with the lack of figurative art until quite late in the sequence; in fact, despite McBrearty and Brooks’s (2000) claims of an age in excess of 50,000 years ago for the painted slabs from Apollo 11 cave, the stratigraphic and dating context (Wendt, 1974; Vogelsang, 1998) leaves no doubt that they date to no more than ca.28 ka ^{14}C BP (ca.33 ka cal BP). It was emphasized, however, that indirect evidence for symbolism could in any case be found in other realms of the archeological record: for instance, the geographical patterning observed in stylistical attributes of the lithic points of the MSA (taken as a proxy for ethnicity), the use of pigments, and the occurrence of personal ornaments and abstract engravings in the Still Bay levels of Blombos cave, dated to ca.75 ka cal BP. “Modern behavior” thus became equated with “fully symbolic *sapiens* behavior”, recognizable archeologically “when artifacts or features carry a clear symbolic message that is exosomatic” (Henshilwood and Marean, 2003, p. 643-4).

Where Europe is concerned, maintaining the logical integrity of the model was achieved by suggesting that the association with the Châtelperronian of artifacts carrying a clear exasomatic symbolic message was spurious. These arguments appeared under different formats, which can be grouped into two major families, one invoking natural (taphonomic), and the other invoking cultural process. Where the former are concerned, it was suggested, for instance, that, at the Grotte du Renne, the key site documenting the use of personal ornaments by Châtelperronian Neandertals, such ornaments were in fact intrusive from the overlying Aurignacian levels (Taborin, 2002; White, 2002). Alternatively, it was suggested that those ornaments could represent items scavenged by Neandertals from contemporary, abandoned Aurignacian modern human sites, evidence for trade between the two groups, or if at all indeed manufactured by the Neandertals themselves, “imitation without understanding” of the product of Aurignacian modern human symbolic crafts (Stringer and Gamble, 1993; Hublin et al., 1996; Mellars, 1999). Whatever their specific format, these arguments shared in common their denial of the Neandertals’ capacity to independently develop symbolic material culture, thereby effectively reconciling the Châtelperronian evidence with the notion that “behavioral modernity” was a species-specific attribute of the African-originated *sapiens* species of humans.

However, as exhaustively argued in a series of papers published at the turn of the century (d’Errico et al., 1998, 2003; Zilhão and d’Errico, 1999a, 1999b, 2000a, 2000b, 2003a, 2003b; Zilhão, 2001; d'Errico, 2003), neither the "imitation" nor the "taphonomic" or "trade/scavenging" solutions to the Châtelperronian problem were consistent with the empirical record. Close scrutiny of the data from the Grotte du Renne showed that the vertical distribution of personal ornaments across the site's sequence was totally inconsistent with the hypothesis that they were intrusive, and yielded evidence (under the form of manufacture debris) that the bone tools and ornaments found in the Châtelperronian levels had been produced at the site, not imported to it. As a result, the only alternative that could stand against the recognition that these levels represented a genuine, independent cultural development of European Neandertals was that of "acculturation" in any of its two different flavors: close-contact acculturation, resulting in imitation (Mellars, 1999), or long-distance acculturation, resulting in re-elaboration (Hublin, 2000). The former was refuted by the obvious differences in choice of blanks and manufacturing techniques between the bone tools and ornaments from the Châtelperronian of the Grotte du Renne and their putative Aurignacian sources of inspiration. The second (which also proposed to explain all other cultural innovations observed throughout the entire duration of the Middle Paleolithic of Europe, namely the practice of burial) implied a double conundrum: that the putative speciation of Neandertals resulted from long-term geographical isolation, preventing gene flux but nonetheless allowing for complete cultural interconnectedness; and that, because long-distance diffusion implies the spread of concepts, not just objects, the cultural recipient of the innovations must have had those exact cognitive capabilities the lack of which the argument was designed to explain!

Thus, although these propositions still survive in one guise or the other, the most informed supporters of the notion that Neandertals were devoid of fully *sapiens* cognition and behavior (as measured by the exact same archeological standards designed to gauge their emergence in the African lineage) have been quick to recognize that only one line of reasoning now remains available for them to maintain that position: and that is the suggestion that not only the Châtelperronian but also the broadly contemporary so-called "transitional" industries of central and eastern Europe were in fact the work of moderns, not Neandertals (Bar-Yosef, 2006). This was of course François Bordes's (1972, 1981) long-held view, one that led him to reject that the Saint-Césaire Neandertal represented the people who had made the artifacts contained in the levels into which it had been buried; instead, it would in fact represent their victims. Arguing along similar lines, Bar-Yosef suggests that the Neandertal remains found in the Châtelperronian levels of the Grotte du Renne are either displaced from the underlying Mousterian or bear witness to the fact that the excavation techniques used at the site mixed the original stratigraphy.

In order to secure the logical consistency of these arguments, it is also suggested that the real technological and typological roots of these early Upper Paleolithic European entities lie not in the preceding regional Middle Paleolithic traditions of stone tool making but in the IUP or Emiran of the Near East; the Bohunician of Moravia and southern Poland would be the most clear case in point (cf. Svoboda and Bar-Yosef, 2003, and the different papers therein). Under the assumption that modern humans manufactured the IUP, the Bohunician (and by extension the Bachokirian of Bulgaria and the Châtelperronian of France) is thus taken as an archeological proxy for the spread of anatomically moderns into the European continent. Such a spread, therefore, would have significantly preceded the Aurignacian, which, until now, supporters of "Out-of-Africa-with-complete-replacement" models had unanimously considered as representing the cultural manifestation of that immigration process.

Where the Grotte du Renne is concerned, however, suggestions that the Neandertal human remains in the Châtelperronian levels are intrusive from the underlying Mousterian are as inconsistent with the horizontal and vertical distribution patterns of archeological finds as were the suggestions that the ornaments in those levels were intrusive from the overlying Aurignacian. As shown by the data in Bailey and Hublin (2006), all of the Grotte du Renne's Châtelperronian levels, from VIII at the top to Xc at the bottom, yielded human teeth. Even if we exclude from consideration the 20 that were recovered in rows 3-7 of the grid, where the marked slope of the stratigraphy makes it legitimate to suspect significant post-depositional disturbance or excavation mix, 14 remain, of which 1 was from level VIII, 1 from level IX, 11 from sublevel Xb, and 1 from sublevel Xc. This distribution follows the same pattern as that of ornaments and bone tools, the concentration in sublevel Xb matching that of the lithic materials upon which the industrial diagnosis of these levels is based. Moreover, groups of teeth thought to come from the same individual on the basis of both age-at-death and morphology are tightly spatially clustered, not scattered, as one would expect if the original position of finds had been significantly disturbed: the three teeth attributed to individual 1 all come from square D10, sublevel Xb1; the three from individual 2 from adjacent squares B5 and B6, sublevel Xb2; the three from individual 3 from square C7, sublevel Xb2; and the four from individual 4 from square C8, sublevel Xb2. Finally, the two teeth (a permanent lower incisor and a permanent upper premolar) from levels VIII and IX, separated from Mousterian level XI by the >50 cm thick level X, are clearly, metrically and morphologically, in the Neandertal, not the modern human range.

These findings are all the more significant if we bear in mind that the morphology of the two deciduous teeth found in level E of Grotta del Cavallo, in Italy, at the base of the site's Uluzzian sequence, is also indicative of Neandertal affinities. They are similar to Neandertal teeth in size, cusp morphology and taurodontism, the latter, in particular, being often present in Neandertal deciduous molars but having never been observed in early modern human juveniles (Churchill and Smith, 2000). There is no doubt that the Uluzzian is a local industrial development rooted in the preceding Mousterian (Palma di Cesnola, 1993; Mussi, 2001), and that the roots of the Châtelperronian are to be found in the preceding MTA is widely accepted since François Bordes's review of the Transition in France. Bordes reconciled this link between the Châtelperronian and the MTA with his perception of the Upper Paleolithic as related solely to *sapiens* people by postulating that the MTA had also been made by *sapiens*. Today, that continuity between the two traditions observed in the different archeological realms, unanimously recognized prior to the Saint-Césaire discovery (cf. Mellars, 1973), carries the implication that the Transition in France, having been an entirely indigenous process, must therefore have resulted from developments intrinsic to the Neandertal world.

The notion of a modern human authorship for the Bohunician rests on three lines of reasoning: 1) that no Levallois blade production is observed in Moravia prior to its emergence; 2) that its reduction strategy is the same as that documented in basal levels 1 and 2 of the Israeli site of Boker Tachtit; 3) that the Bohunician therefore represents an intrusion into the local sequence of a technology diffusing from the Levant whence modern humans are supposed to have spread into Europe. These arguments assume that the technological transition observed at Boker Tachtit is a unique event and that identifying an assemblage belonging to one of the stages of that transition implies assignment of its manufacture to the population bearing such a technological "mutation". It is clear, however, that no migration is required to explain the diffusion of technologies; moreover, the apparently intrusive nature of the Bohunician is simply an artifact of the gap of at least ten millennia that exists in the Moravian sequence between the latest Micoquian of Kůlna and the earliest Bohunician. And, in actual fact, the evidence from the sites of Piekary IIa and Księcia Józefa, in southern Poland (Sitlivy et al., 1999a, 1999b, 2004; Valladas et al., 2003), document the local development of volumetric, Upper Paleolithic methods of blade debitage out of Levallois flake-based technologies between ca.50 and ca.40 ka cal BP, i.e. during the time covered by the Moravian gap. Parsimony dictates that there is no need to look into the Middle East for a source for the Bohunician when a better alternative, chronologically and geographically closer, is available.

Given the lack of human remains, the authorship of the Bohunician must remain an open issue, but the evidence for cultural continuity with the regional Middle Paleolithic is strongly suggestive that the earliest Upper Paleolithic of Moravia relates to Neandertals, not moderns. The same reasoning pertains where the Bachokirian of Bulgaria is concerned. Contra Gleń and Kaczanowski (1982), who had suggested that the human teeth from Bacho Kiro had Neandertal affinities, Churchill and Smith (2000) subsequently concluded that aspects of size, shape and crown morphology aligned this material more with modern humans than with the Neandertals; this conclusion, however, applied only to material found in the Aurignacian levels, the single human remain from the Bachokirian being a taxonomically undiagnostic left mandibular fragment with deciduous first molar.

This review of the currently documented associations between human fossils and archeological cultures suggests that, from Bulgaria in the East to France in the West, the earliest Upper Paleolithic of Europe is a Neandertal phenomenon. This conclusion is supported by the available chronometric evidence which places the emergence of all of these technocomplexes ca.40 ka ^{14}C BP (ca.44 ka cal BP) or earlier, whereas the age of Europe's earliest directly dated modern human remains (currently, the Oase 1 mandible; Trinkaus et al., 2003) falls in the range of ca.35 ka ^{14}C BP (ca.40.5 ka cal BP). Once this conclusion is reached, the implications are inescapable (Zilhão, 2006, n.d.). Unless we fall into the trap of using double standards, the stylistical diversity and tight geographical patterning observed at this time in lithic typology, as well as the occasional abstract markings on bone tools (for which a major precedent is provided by the cupules decoration of the slab covering the burial pit of the much earlier La Ferrassie 6 child) and the use of personal ornaments (documented not only at the Grotte du Renne but also in contemporary levels at Quinçay, Roche-au-Loup, Saint-Césaire, Trou Magrite, Ranis, Willendorf II and Bacho Kiro) can only be interpreted along the same lines as those nowadays widely accepted for similar features of the African Transition: as unequivocal evidence of modern human behavior.

Put another way, the latest European Neandertals may have been anatomically archaic, but nonetheless were clearly behaviorally modern.

The broader implication for studies of human evolution is twofold: 1) that, although inter-related, the two domains of anatomy and culture did not evolve in tandem and, therefore, that we cannot approach the record of past human behavior with the expectation that it must have been species-specific; 2) that the acquisition of the “hardware” required for modern behavior must predate the differentiation of the Neandertals, i.e., must already have been a feature of *Homo heidelbergensis*, if not of late *Homo erectus/ergaster*. Where the immediate fate of Neandertals at the time of contact with immigrating modern humans is concerned, the implication is that biological admixture and cultural exchange are to be expected. Where the former is concerned, that is indeed what both the genetic and the paleontological evidence increasingly suggest (cf. Templeton, 2005; Trinkaus, 2005; Zilhão, 2006); the latter is documented by the presence in the Protoaurignacian and Early Aurignacian of types of ornaments previously completely unknown in unequivocal, African and Near Eastern modern human-associated archeological contexts but widely used in the earliest Upper Paleolithic, Neandertal-associated cultures of Europe, such as pierced and grooved animal tooth pendants and *Dentalium* shell beads (Zilhão, 2006, n.d.).

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NESPOS: From data accumulation to data management

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Neanderthals are the best documented fossil humans. More than 300 Neanderthal individuals from about 130 sites in Europe and Western Asia are known up to date. In addition, several thousand sites yielded archaeological finds that can be linked to Neanderthals and offer important evidence for the reconstruction of Neanderthal subsistence. Due to major advances in excavation and analysis techniques as well as the increasing multidisciplinarity of Neanderthal research, the amount of data has exploded within the last two decades. At least some 150 scientific institutions worldwide are engaged in research on Neanderthals and various disciplines contribute data to our knowledge on Neanderthal behaviour and Pleistocene environment. A huge amount of data is scattered to different institutions and different media and, therefore, difficult to be handled by the means of conventional data management.

In addition, research techniques and goals have changed significantly from the mere description of isolated topics or single sites to complex modelling of subsistence and human behaviour on regional and supra-regional scale. Serious modelling and comprehensive inter-site comparison need large samples that are statistically significant. But the accessibility of data is a severe problem for various reasons:

- Objects are scattered to collections worldwide and require huge travel
- budgets to be studied in detail.
- Some curators prefer a restricted access policy for their objects.
- Most sites have been discovered decades ago. First publications of these old excavations have been preserved only in very few places.
- Some sites or analyses are only described in journals with limited regional distribution or published as so called grey literature only (M.A. thesis, PhD thesis etc.).
- The multidisciplinary of research causes a multitude of media of publication.
- A register of collections, objects and additional data as reference guide is not available.

In palaeoanthropology, the application of CT and computer-assisted 3D-reconstruction have become more and more important, as these techniques have proven to be highly useful for the study of fossil hominids. For these purposes, various software packages, mainly adopted from medical applications, have been used by palaeoanthropologists. In archaeology, the use of 3D- images of objects, of site topography and GIS- mapping is increasing rapidly. However, the necessary software is expensive and requires a lot of technical knowledge so that only few institutes are able to use high-quality 3D-imaging.

Although Neanderthal research has, therefore, benefit during the last decades from new exploration and analysis techniques as well as greater multidisciplinarity, the scientific progress is slowed down by limited access to information, originals and software and a low degree of inter-group-collaboration (Weber 2001). In addition, a tool for structuring the diverse data and allowing a quick content retrieval is urgently needed.

The online platform NESPOS (Neanderthal Studies Professional Studies), developed within the 6th Framework of the EU tries to combine advanced content management, collaboration and visualisation features (Semal et al. 2004; Gröning et al. In press; Weniger et al. In press). It is designed to work as a constantly growing register of all kinds of data on Neanderthals, from simple literature references up to micro-CT-scans. It includes the 3D visualisation software ArteCore and GeoCore for real time exploration of 3D-models. ArteCore is designed to visualize fossils and artefacts (Semal et al. 2005). GeoCore is a GIS and exploration tool for 3D terrain models and virtual excavation sites. This software package was developed to allow anthropologists and archaeologists a basic and easy to handle 3D-data management: Even researchers that are not yet familiar with 3D-data handling will be able to manage the software.

The distinction between public and private spaces in NESPOS allows to keep data either private or to share it with colleagues. The system could be used as a working platform to manage data of personal or group research in a standardised environment and to facilitate international collaboration. Research results and data from private spaces can be passed over to the public space of NESPOS easily once the analysis have come to an end and have been published. In general, the collaborative tools of the NESPOS system like comments attached to objects and discussion forums will enhance data exchange. Prehistoric data as highly imprecise data can be interpreted in various ways. Discussions and comments on the different interpretations are therefore important means to improve and qualify these data and enhance their standardisation.

The idea behind NESPOS is to provide transparency and preservation of the precious originals by creating a virtual public collection that is open to the scientific community using latest information technology.

Since March 2006 the NESPOS Society e.V. is responsible for maintaining the NESPOS system. Full access to NESPOS is gained by becoming a member of this society and paying an annual membership fee that is necessary to cover the costs.

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DEUQUA Session 1

Rhine session and Archeologicals sites

Conveners: FRANK PREUSSER & ERNST BRUNOTTE

Rhine session

The Heidelberg Drilling Project (Upper Rhine Graben, Germany)

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In late 2005 and early 2006 two research core drillings are presently realized in Heidelberg and near to the town of Viernheim, in addition to two already existing core drillings on the Park Isle in the River Rhine within the City of Ludwigshafen. All drillings are located within the Heidelberg basin of the Northern Upper Rhine Graben, where one of the thickest successions of continental Quaternary of Europe may be expected. As they are planned, each drilling will expose the complete Quaternary and some 100 mts of underlying Pliocene. In this Archive of fluvial to lacustrine deposits the Pliocene to Quaternary transition may be focused, plus aspects of the middle to late Pleistocene Glaciations.

The Questions to be addressed in this project include:

- investigations of the sedimentary environments and sediment provenance,
- the 3D-architecture of the basin,
- the climate and neotectonical contol of the Geosystem of the Rhine and Neckar.

Various dating techniques will also be applied to support the stratigraphical interpretation of the successions.

Only first results of the drillings will be presented, plus results of the pre-project investigations.

Late Quaternary landscape evolution and soil formation in the range of the loess covered Middle Terraces in the central Lower Rhine Embayment

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The study area located in the central Lower Rhine Embayment northwest of Cologne is characterised by the transition from the loess covered Middle Terraces to the Lower Terrace of the river Rhine. Attuned to the Lower Terrace, numerous valleys exist that partially show asymmetrical profiles and dissect the area of the Middle Terraces.

The existing stratigraphy of the Rhine terraces in this area is mainly based on geomorphological mapping due to the lack of natural outcrops. However, drilling cores along cross sections give evidence of thick loess deposits on the lee side that in some cases veil underlying terrace steps or simulate none-existing steps.

Geophysical methods (geoelectrics and radiomagnetotellurics) to map the basement of the

Middle Terraces (and respectively the surface of the Tertiary sands) and the basement of the loess sediments are carried out laminary. These methods are calibrated by drilling cores and laboratory analysis of electric resistivity of representative samples. Using geomorphological and pedological methods, sediments and soils and their structural conditions are investigated to reconstruct the Late Quaternary landscape and valley formation.

In addition to the loess sequences as a record for the Pleistocene climate and landscape history, erosion stages of the recent soils and thick colluviums provide valuable information of the Holocene environmental change.

The sediments under investigation are interpreted morphogenetically and chronologically. Absolute dating is carried out by the application of Optically Stimulated Luminescence on the loess and colluvial sequences and ESR dating on the terrace sediments.

Preliminary results are presented and discussed.

Pliocene and Early Pleistocene chronostratigraphy of Middle and Northwestern Europe based on pollen analysis: an errant concept and a new approach

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The currently used chronostratigraphic subdivision of the Pliocene and Early Pleistocene of Middle and Northwestern Europe is mainly based on pollen analytical investigations by Zagwijn (1957, 1960, 1963) carried out in the Lower Rhine Embayment.

This stratigraphical system is almost entirely based on the interpretation of quantitative changes in pollen content of mostly fine-grained fluvial deposits. These changes have been interpreted as reflecting vegetational change. Only the pollen analytical definition of the Plio-Pleistocene boundary near the Gauss-Matuyama boundary at 2.58 Ma has been defined based on Last Appearance Dates (LADs) of a number of thermophilous, Tertiary species such as *Sequoia, Taxodium* or *Liquidambar* (Florschütz & van Someren, 1948).

The pollen content of a sediment is not only determined by the regional vegetational pattern, but also by local effects related to edaphic factors and sedimentary facies. Reworked pollen grains add another problem that makes the interpretation of pollen assemblages a task which cannot be carried out straightforward.

During development of new lithostratigraphic systems both in The Netherlands (Weerts et al., 2003) and in Germany (Kemna, 2005, in press) for the Pliocene and Lower Pleistocene, the database has been improved and the existing data have been subject to a critical revision. This revision also dealt with the ways of interpretation of pollen assemblages and was combined with the comparison of lithostratigraphical data, provenance and sedimentological studies and paleogeographical considerations.

Most of the quantitative changes found in pollen assemblages are due to sedimentological facies changes of the adjacent fluvial systems. It can be demonstrated that the subdivisions as defined at the type sections cannot be taken as valid on a regional scale. Moreover, lithostratigraphical data concerning provenance have revealed severe contradictions within the pollen-stratigraphical system.

The results have led to the conclusion that the chronostratigraphic system is wrong and should be abandoned.

Unfortunately, there is no alternative concept in sight. We have to face that it is currently not possible to adress the sedimentary record of the Plio-Pleistocene time slice in more precise terms than “Late Pliocene” (at least 1 Ma) or Early Pleistocene” (about 1.5 Ma). Here, the need for a reliable method for absolute age dating becomes most urgent. Magnetostratigraphy has not proved to be of high effectiveness in terrigenous sediments. Biostratigraphy, however, will continue to contribute valuable results to chronostratigraphy, given the prerequisite that the interpretation of data will not be exaggerated.

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Burial dating of fluvial sediments from the Lower Rhine Embayment, Germany

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The system of the River Rhine is one of the major fluvial networks in Central Europe and connects the main areas affected by Quaternary glaciations, i.e. the Alps and the European plain. Sediments deposited by the River Rhine document in detail climatic and environmental changes since Late Cenozoic times, thereby forming an excellent terrestrial stratigraphical archive. However, there are enormous problems associated with establishing absolute chronologies for such sediments, especially for the Pliocene/Pleistocene boundary in the Lower Rhine Embayment (LRE). Burial dating of (fluvial) sediments using *in-situ* produced cosmogenic nuclides could provide absolute ages for sediment sequences, which are difficult or even impossible to date with other well-established techniques.

Burial dating utilises the fact that sediment was exposed to cosmic radiation prior to burial and that individual cosmogenically-produced nuclides decay at a constant rate once this sediment has been buried. In this case, the decay ratio of two cosmogenic nuclides, ^{26}Al and ^{10}Be, which are abundant in quartz minerals, can be used to calculate the time when a sediment was shielded from cosmic rays. The upper dating limit is around 5 Ma due to technical evolution of the accelerator mass spectrometry (Granger and Muzikar, 2001). Burial dating with ^{26}Al and ^{10}Be is quite well developed in the field of cave sediments (e.g. Anthony and Granger, 2004), but there are only a few studies that have attempted the dating of fluvial terraces (e.g. Wolkowinsky and Granger, 2004).

We are currently testing to date fluvial sediments of the River Rhine using the burial dating approach outlined above. For this, we have obtained samples from two pits in the LRE, Weilerswist, an open gravel pit south of Cologne and Hoher Stall, a clay pit close to Brüggen-Bracht in the northern part of the LRE. Three units are exposed in both pits: the Kieseloolite Formation, the Reuver clay, and the Upper Terrace Formation (UT). The stable heavy mineral composition indicates a Pliocene age for the Kieseloolite Formation, while a less stable heavy mineral assemblage can be found in the Lower Pleistocene sediments of the UT. Furthermore, the onset of typical volcanic heavy minerals in the UT3 subformation is linked to the onset of the Eifel volcanism. These fluvial gravel strata are separated by the Reuver Clay. This clay is an important marker horizon in the whole LRE. It contains a polarity change, interpreted as the Gauss-Matuyama boundary and its base coincides with typical Tertiary pollen assemblages. It can also be correlated with the Neogene Mammal Zones NM16a and MN16b (Boenigk and Frechen, 2006). These marker strata, which are relatively easy to identify, provide reliable independent age control against which our burial dating results can be compared. First results of this work are expected for the second half of the year and will be presented at the conference.

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Imprints of climate change, sea-level oscillations and glacio-hydro-isostacy in the Rhine-Meuse sedimentary record (the Netherlands)

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Multidisciplinary analysis on high-resolution undisturbed core material gives new insight in the development of the Late-Pleistocene Rhine-Meuse system (southern North Sea Basin, the Netherlands). Over 120 quartz OSL-dates allowed constructing a detailed geochronological framework and makes the Rhine-Meuse record by far the best dated Late-Pleistocene fluvial record in the world.

The Late-Pleistocene Rhine-Meuse sedimentary sequence starts with fine-grained sediments from the last interglacial and early glacial period (130-80kyr BP). These sediments are overlain by a massive sequence of coarse-grained sediments that were deposited between 80-15 kyr BP. The sequence is mapped as twelve sedimentary units based on regionally traceable bounding surfaces and sediment characteristics. Strong climatic and sea-level controls are evident as variations in sedimentary characteristics (grain-size, lithology, geometries) and architecture (erosion-deposition history, reworking, preservation) while part of the system architecture is related to forebulge upwarping and collapse, caused by glaciations in Scandinavia and Britain.

Results from 3D landscape evolution modelling indicate a strong non-lineair relation between sediment source areas (Germany) and the depositional record (Netherlands) and explains grain-size and incision/aggradation trends. The model shows that particularly the timing of delayed responses needs to be taken into account to explain the type and timing of sediment-delivery to the study area.

Archeologicals sites

The fossil vertebrate fauna from the Neanderthal – results and problems of new findings from the type locality of *Homo neanderthalensis*

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The rediscovered cave sediments from the type locality of *Homo neanderthalensis* yielded beside new exciting findings of human remains and artefacts an extensive assemblage of animal bones and teeth. The material consists to a large extent of small mammals, mainly rodents, but also of large mammals. Lower vertebrates are represented by fish, some amphibian, and abundant bird remains, mainly documenting the snow grouse *Lagopus* sp. Reptiles are underrepresented.

The fact that the fossil bearing sediments were excavated from the cave and dumped at the base of the former rock face, makes the chronostratigraphical allocation of the material very difficult. Despite the fact that the faunal assemblage appears to be widely coherent, AMS datings suggest at least three different ages: Middle Palaeolithic (Mousterian), Upper Palaeolithic (Gravettian), and Latest Pleistocene. The compiled faunal list consists of a minimum of 48 vertebrate taxa, including 42 mammals. At least four mammal species are Holocene or Recent in age. The application of the Gocad-system by S. Feine (Tübingen) allowed a rough chronostratigraphical assignment of the fossil bearing sediments. This makes it possible to attribute extinct mammals like the cave bear *Ursus spelaeus* to the Middle Palaeolithic, while the Norway lemming *Lemmus lemmus* and the steppe pika *Ochotona pusilla* mainly are found in the Upper Palaeolithic sediment pile. Some snow grouse remains were AMS-dated close to the Pleistocene/Holocene boundary.

Magnetic Susceptibility Stratigraphy and Enviromagnetics of Middle to Upper Palaeolithic Cave Sediments from Southern Germany (Hunas Cave Ruin, Franconia and Hohle Fels, Swabia)

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Enviromagnetism, the magnetism of sediments and soils (paleosols), describes the occurrence, abundance and properties of iron-bearing minerals in the environment. Iron takes part in numerous biological processes, which are very often limited by its availability. Consequently, microbially mediated redox processes are the far most important processes, which control occurrence, abundance and properties of iron-bearing minerals in sediments and soils. These processes control also weathering, diagenesis of sediments and pedogenesis. Therefore, magnetic methods are powerful in environmental characterisation and reconstruction, precisely because they can easily detect, trace and even monitor the pathways and fate of ferromagnetic minerals in the environment.

Cave sediments provide valuable paleoclimatic information. They accumulate from weathering products of the carbonatic rocks in which the caves were formed and from sediments which were blown or washed into the caves. In the Pleistocene, during interstadials and interglacials when more humid conditions predominate, increased diagenesis and pedogenesis occur which cause physical-chemical alteration of the sediments during and after the deposition. These alterations result in the enhancement of magnetic minerals. Therefore, magnetic parameters as function of depth in cave sediments can serve as a proxy for palaeoclimatic variations allowing for a close match with the isotope record from ice cores as well as with all kinds of high resolution palaeoclimatic archives (Dalan & Banerjee 1998, Ellwood 2004, Evans & Heller 2003).

Here we present the results of enviromagnetic investigations from Middle to Upper Palaeolithic cave sediments from Southern Germany (Hunas Cave Ruin, Franconia and Hohle Fels, Swabia). The results of magnetic measurements from centimetre spaced samples were plotted as function of stratigraphy and correlated to the isotope record from Greenland ice cores (North GRIP Members 2004). Based on recently dated flowstones (TIMS-U/Th-method), the sedimentary infill of the Hunas Cave Ruin is younger than 88 ka (Rosendahl et al. this volume). In the Hohle Fels cave, ^{14}C-dating and archaeological evidences prove sedimentation roughly from 40 to 10 ka (Conard & Bolus 2003). The enhancement of magnetic minerals in the cave sediments during interstadial phases causes higher values in magnetic proxy parameters, reflecting warmer and more humid climatic conditions. On the other hand, low values are observed in intervals which represent cold and dry stadial phases. These results enable the correlation of the enviromagnetic records to the Greenland interstadials and stadials. Alternative correlation models will be discussed against the background of chronometrical, stratigraphical, archaeological and sedimentological constraints.

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Human palaeoenvironment in the Eastern Alps during the Last Glacial Cycle

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The Eastern Alps were covered with ice during the Last Glacial Cycle (Wuermian) but glaciers fluctuated and there was no constant ice cover all over the Alpine region. The maximum ice extent during the Last Glacial Maximum (LGM) is compiled on the map from van Husen (1987) but previous ice extentions are almost unkown. Cave bear remains document animals within the glaciated area of the Alps during the Wuermian. Ice-free conditions are assumed as prerequisite for a visit of the cave. But no clear succession of warm climatic conditions with fauna and cold climate conditions with ice cover has been reconstructed so far.

The artefacts encountered in these alpine bear caves were traditionally ascribed to a Mousterian (Neanderthal) or an early Aurignacian (modern human) tradition. Unfortunately, the cultural assemblages are often old excavated, small, and rather undiagnostic. Despite a number of sites, the early human colonization of the Eastern Alps is still not well known. The human palaeoenvironment in the Eastern Alps needs revision.

DEUQUA session 2

Open Session

Convener: Margot Böse

Middle to Late Quaternary stratigraphy of Switzerland and correlation with high-resolution marine records

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Due to its position downwind of the North Atlantic, the Swiss Alps are an important region for the reconstruction of past changes in atmospheric circulation and environmental conditions. In this context, a well-established stratigraphy is essential for deciphering long to mid-term trends of Quaternary climate change. Most of the late Middle Pleistocene stratigraphy of Switzerland is based on evidence from the sites of Thalgut and Meikirch. The basal part of the Thalgut site consists of glacial sediments followed by lacustrine deposits (Schlüchter, 1989), which bear pollen of *Pterocarya* (wingnut) and a substantial amount of *Fagus* (beech) (Welten, 1988). This implies a correlation of this interglacial with the Holsteinian, which may either be an equivalent of Marine Isotope Stage (MIS) 11 (de Beaulieu et al., 2001) or MIS 9 (Geyh and Müller, 2005). This interglacial is, at Thalgut, followed by a second sequence of glacigenic deposits. This unit is cut by an erosional surface that is interpreted to represent interglacial conditions. Above follows a gravel unit that presumably reflects deposition under cold climatic conditions but without any indication of an input of Alpine material. Hence, petrography of this latter unit does not provide any evidence for the presence of a glacier close to the site. The lake sediments above this gravel unit are the equivalent of the Eemian Interglacial as indicated by pollen analyses (Welten, 1988) and luminescence dating (Preusser and Schlüchter, 2004). In previous outcrop situations, two units of pro-glacial deposits above the Eemian sediments were exposed. These two units were separated by a weathering horizon implying that two independent Würmian ice advances reached the Thalgut area.

At the Meikirch drilling sites, a sequence of about 70 m of lacustrine deposits is found below c. 40 m of proglacial outwash sediment (Welten 1982, 1988). A re-interpretation of the sequence based on luminescence dating, detailed logging of the sediment cores and reviewing existing pollen data implies a correlation of the lacustrine sequence with the period from late MIS 8 to late MIS 7 (Preusser et al., 2005). If this interpretation is correct, MIS 7 would include three periods with a pronounced interglacial character, which are apparently reflected in the marine record by three distinct peaks towards warmer environmental conditions.

The Late Pleistocene climatic evolution of the northern Alpine Foreland has recently been reviewed by Preusser (2004). The most prominent issues in the present discussion of the Late Pleistocene in Switzerland are the well-developed and well-dated MIS 3 site of Gossau (Preusser et al., 2003) and evidence for at least three independent glacial advances into the Swiss lowlands during the last glacial cycle (MIS 5d-2) (Preusser et al., 2003; Preusser and Schlüchter, 2004; Preusser et al., 2006). These three Würmian glaciations are assigned to MIS 5d, MIS 4, and MIS 2, respectively. Sedimentary evidence as well as environmental conditions reconstructed from pollen analysis indicate that glaciers retreated far back into the Alps after each of these glacial advances. The last glaciation of the Swiss lowlands (MIS 2) was apparently the most extensive ice advance during the Würmian. It reached the lowlands shortly after 30,000 yr ago (Preusser et al., 2006), and started to decay from its maximum position soon after c. 21,000 yr ago (Ivy-Ochs et al., 2004).

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Loess/paleosol sequences as stratigraphical database of the Brunhes Chron in Upper Austria

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This paper is focussing on stratigraphical studies of the loess/paleosol sequence of the former loam pit Wels/Aschet in Upper Austria, which is representing large parts of the Brunhes Chron. The profile is situated on top of the fluvioglacial terraces of the classical Günz, (Ältere Deckenschotter) of the Northern Alpine Foreland stratigraphy. The covering layers of Wels-Aschet include a complex series of five interglacial pedocomplexes alternating with loess loam – a record which is characteristic for Middle Pleistocene loess profiles in the study area (Terhorst et al., 2003). The top of the sequence is formed by residual strata originating from the last glacial phase.

This study summarizes an interdisciplinary approach to build up a Middle Pleistocene stratigraphy and to establish a paleomagnetic database by the use of pedostratigraphical, sedimentological, mineralogical methods as well as OSL-datings for the region.

Whereas in Europe for the Upper Pleistocene Period stratigraphical models based on marker horizons and dating methods (TL-, OSL-, and ^{14}C-datings) are available for several loess regions, for the Middle Pleistocene it has not been possible yet to date the terrestrial sequences continuously. Consequently, there is no common ground for neither regional, nor interregional correlations in Europe. However, one main objective is to establish the stratigraphical tool of Magnetic Polarity Analysis in combination with paleopedological studies and OSL-datings for the Upper and Middle Pleistocene loess/paleosol sequences, in order to decode and to correlate the paleoenvironmental information preserved within paleosols and sediments.

For Mesozoic to Quaternary times, the geomagnetic polarity record is essential for the construction of geological time scales. Reversals of the Earth's magnetic field are globally synchronous, enabling correlation and dating of the geological archive (Berggren et al., 1995). Global paleomagnetic databases have been produced which can be used as stratigraphic markers in Pleistocene loess records.

Recently, first studies in loess records of Austria gave evidence of most reversal excursions in the Brunhes Chron.

Besides paleomagnetic investigations, the stratigraphical framework for the paleopedological and paleoclimatic examinations in the Upper Pleistocene and parts of the Middle Pleistocene will be set by OSL-datings.

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Pleistocene Pollen Records from Schöningen, North Germany

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The Pleistocene sequence of the Schöningen lignite mine contains a number of interglacial and interstadial limnic and peat deposits, travertine tuff, soils, tills and fluvioglacial as well as loess deposits. There is evidence of four interglacials younger than the Elsterian glaciation and preceding the Holocene. The complex Quaternary sequence contains six major cycles.

The sequence begins with Late Elsterian glacial and three interstadial deposits formed in shallow basins, locally named Offleben 1, Offleben 2 and Esbeck (Urban et al., 1988).

Cycle I is assigned to late parts of the Holsteinian interglacial, characterized in its terminal phase by Abies, Pinus, Picea and Pterocarya as well as by the water fern Azolla filiculoides. A strong cooling is recorded by a significant increase of Artemisia and grasses during the following Buschhaus A Stadial, which is considered to mark the onset of the Saalian Complex sensu lato (penultimate glacial-complex).

The lacustrine sediments of Cycle II, Reinsdorf interglacial sequence (Urban, 1995) have been found to occur at archaeological sites Schöningen 12 and 13 (Thieme,1997). Recent investigations give evidence for at least 13 Local Pollen Assemblage Zones showing a five-fold division of the interglacial and a sequence of five climatic oscillations following the interglacial (Urban, 2006). From the relative high values for grasses and herbs in the inferred forested periods of the interglacial, a warm dry forest steppe climate can be deduced. The stratigraphic position of the throwing spears (Thieme, 1997), can clearly be allocated to Reinsdorf Interstadial B (level II-4) characterized by an open pine-birch forest. Uppermost parts (level II-5) are representing te transition into a periglacial environment indicating the definite end of cycle II.

The Schöningen Interglacial (Cycle III) represents the youngest of the pre-Drenthe (Early Saalian Stadial) interglacials (Urban, 1995). A pedocomplex developed in alluvial loess (Cycle IV), younger than the Drenthe Stadial of the Saalian glaciation, is succeeded by a sequence of soft travertine and peat (Cycle V) representing Eemian Marine Isotope Stage 5e (MIS 5e) and MIS substages 5d, 5c.

Channel sediments provide evidence of the Weichselian Late Glacial and the Holocene (Cycle VI).

Summarized it can be concluded that the Schöningen Pleistocene terrestrial pollen record represents MIS 5 and tentative correlatives of MIS 7, 9 and 11 .

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Reconstruction and comparison of the climatic evolution of middle and upper Pleistocene warm periods and the Holocene

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Climate of the last hundred thousands of years was highly variable, when the genus we belong to, *Homo*, was already living in our area. The magnitude of change *Homo* had to deal with can be assessed by quantitative climate reconstructions using so-called proxy data, e.g. pollen and botanical macro fossils. Major challenges for reconstruction methods using botanical data are the lack of modern analogous plant communities and the quantification of the reconstruction uncertainty. To overcome these problems, an Indicator Taxa Method has recently been developed that is based on probability density functions (‚pdfs') for describing the plant-taxon relationship (‚pdf-method'), using Bayesian statistics (Kühl et al. 2002). The method has been applied for reconstructing January and July temperatures of the Eemian (~126-118.000 yr BP) (Kühl & Litt 2003, Kaspar et al. 2005) and Holsteinian interglacial (~300.000 yr BP, lasting ~16.000yrs) (Kühl & Litt 2006). Here a detailed reconstruction of January and July temperature and additionally annual precipitation is presented for the Holsteinian, the Eemian, the Early Weichselian (118-80.000 yr BP), and the Holocene. It is shown how the warm periods differed in climate stability and climatic trend and what quantitative change *Homo neanderthalensis* and his relatives faced when an interglacial came to its natural end. In particular the Early Weichselian is characterized by strong climate changes with an increased continentality that caused dramatic vegetation changes.

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Glaciation during the Younger Dryas in Europe's mountains – an overview of climatic implications

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The Younger Dryas was the last return to severe cold conditions prior to early Holocene warming and is recorded in several lateglacial proxy records in Europe and elsewhere on Earth. Although specific localised and regional studies have been conducted and initial numerical modelling results of Younger Dryas climate exist, no attempt has so far been made to compare these data on a larger scale to arrive at a unifying concept of European climate variability as manifested, for example, in the extent of glaciers across Europe's mountains. Here we present a first attempt to draw together recent data gathered from the Scottish Highlands, selected sites from the European Alps and other dated sites synthesised from the literature. In all these areas, the extent and style of glaciation and glacier response to Younger Dryas climate change appears to be strongly controlled by basin topography, aspect, glacier size and local/ regional temperature and precipitation patterns. Thus, once the pattern of glacier distribution is established and numerically constrained, local and regional differences can be used to reconstruct palaeoclimatic variables such as the equilibrium-line altitude (ELA), palaeo-precipitation and palaeo-wind direction. Examples of how these approaches can be applied will be presented using two examples from the far NW Scottish Highlands and two valleys in the Central Alps. The results presented here demonstrate that the pattern and size of glaciation during a certain period of time, in this case during the Younger Dryas, contains useful and important information on climatic boundary conditions that is crucial to test and refine numerical models used in the prediction of future climate change.

The sturzstrom event of Feld (Matrei/ Eastern Tyrol/Austria): A forgotten catastrophe during early human settlement in the Alps?

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As sturzstrom (rock avalanche) events in the Alps have been rare within human history, they are widely underestimated regarding their possible impact. Understanding the process – the geological and geomorphological boundary conditions, the triggering mechanism (e.g. climate, earthquakes) and dynamics – is crucial for the identification of Alpine areas that are at risk.

The sturzstrom deposit of Feld (min. 0.7 km²) lies within the narrow part of the Isel valley, a major S-N running Alpine lifeline. The outcrops show a matrix-supported diamictic facies with angular boulders of amphibolite and gneiss with a diameter of up to 1m "swimming" in a matrix of sand to fine gravel size. The maximum block size on the surface ranges from 5 to 20 m^3. The lithology of the rocks pinpoints to a provenance from the steep backwall of the northern part of the cirque of the Rotenkofel (2762 m a.s.l.) (LINNER, 2003). Considering the minimum travel distance and the lowest occurrence of the deposits (~ 930 m a.s.l.) the former sturzstrom is characterised by an overall slope angle (Fahrböschung; β) of ~ 18-19°. Based on the diagrams (tanβ versus volume) by ERISMANN & ABELE (2001) and on first field estimates a volume of the sturzstrom event of ~ 0.01-0.02 km^3 seems to be a realistic assumption.

According to a first model of event reconstruction the failure was preceded by creep deformation. Immediately within the first phase of the sturzstrom a total disintegration of the collapsed mass and thus a fluidisation occurred. Funnelled by a tributary valley the downward moving mass collided with the opposite flank of the Isel valley and split in two branches, up and downstream of the Isel valley. The sturzstrom blocked the Isel resulting in impounding a lake in the Matrei Basin upstream of the sturzstrom deposit. Nothing has yet been known regarding the timing of the event as well as the duration of the damming. On the basis of geomorphological investigations VEIT (1988) argued for a lateglacial event. In order to address this open question we followed two dating approaches: (i) Surface exposure dating (SED) of sturzstrom boulders. (ii) Radiocarbon dating on organic material found in a 20 m long sediment core in the backwater area.

The first SED-results of 4 boulders date consistently within Roman to early medieval times and thus imply a historic sturzstrom event. Radiocarbon dating from lake deposits is in progress. It has to be emphasised, that this part of the Isel valley belonged to the major Alpine traverse via the Felber Tauern since the Roman times and before. It is therefore surprising that no documents or myths exist about this event. According to our first hypotheses this natural disaster happened during the "Migration Period" following the end of Roman authority, when a severe change of population occurred within the Alpine valleys (STADLER, 2006). As a result the written documentation related to the Alpine region ceased for hundreds of years.

Our first results of this investigation fill a gap in the history of human settlement of Eastern Tyrol. However, a combination of geoscientific and historian investigation methods is needed to further constrain the timing sturzstrom event and its impact on ancient society and traffic.

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Cosmogenic Dating (Exposure and/or Burial) of Stone Artifacts: Additional Dating Tool in Archeology?

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Although the stone artifact can be dated either absolutely or directly by several dating techniques (^{14}C, U-series, electron spin resonance, $^{40}Ar/^{39}Ar$, thermoluminescence etc…), there is a substantial need to apply an additional dating tool in archeology beyond the ^{14}C limit and independent of the former dating methods. The Accelerator Mass Spectrometric (AMS) analysis of in situ produced cosmogenic isotopes, like ^{10}Be and ^{26}Al, will provide the direct exposure (using the production rates of the cosmogenic nuclides) and burial (using the decays of the cosmogenic nuclides) dating of siliceous artifacts. The potential pre-exposure outlines the major risk in exposure dating, so that the lithic artifacts have to be continuously exposed or the amount of pre-exposure has to be known. The artifacts and sediment samples (unworked flint nodules embedded in bedrock) have to be selected from the same layer for burial dating. Paleolithic and Neolithic siliceous tools either exposed or buried for several thousand to hundred thousands of years can be dated. For instance, stone artifacts from Egypt (Ivy-Ochs et al., 2001) and Israel (Boaretto et al., 2000; Verri et al., 2002; Verri et al., 2004) were successfully dated with this methodology.

In this study, four different chert artifacts from archeological sites in Seboruco and La Chuchita, in Cuba, were treated for surface exposure dating with ^{10}Be and ^{26}Al. Modified chemical and physical procedures were followed to extract ^{10}Be and ^{26}Al, in order to reach the suitable ^{27}Al levels required for a successful AMS measurement (^{27}Al < 100 ppm). ^{10}Be measurements of two chert samples from Seboruco were completed, whereas the preparation of the samples from La Chuchita is still continuing. Cosmogenic ^{10}Be concentrations in two Seboruco samples have yielded the calculation of apparent exposure ages of 146 and 21 ky BP. These results are fitting archeological/industrial and field contexts.

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Public Lecture

New results on the Neanderthal type specimen and on the rediscovered locality

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The discovery of the partial human skeleton in the Neander Valley in August of 1856 turned the 19th century world on its head and enflamed the discussion about the existence of fossil humans with ferocity that had never been known before. Although human skeletal remains and artefacts were discovered alongside the bones of extinct animals since the end of the 17 th century, these finds were not acknowledged by the scientific community. Today, Boucher de Perthes' hand axes are as legendary as the beautiful Neanderthal skull from Gibraltar. At the time of their discovery, the finds and discoverers were mocked and scorned. This changed when the following two momentous events coincided:

While clearing out Kleine Feldhofer Grotte in 1856, quarry workers recovered a human skeleton which was first identified as that of a cave bear. Fuhlrott identified the bones as human a few weeks later when he came to visit the quarry owner and received the bones as a gift. Afterwards, Fuhlrott suspected that he only received the bones because of the false assumption that they were bear bones. He wrote: "It is interesting that the abnormal condition of the skull calotte and the known accumulations of animal remains in other caves caused the bones to be identified as cave bear bones instead of human remains and that I probably have this mistake to thank for the acquisition of the Neanderthal find" (FUHLROTT 1859, 137).

In time following, he developed the theory that the non-modern anatomical characteristics of the skeleton were features of an archaic fossil human form. Luckily, the progressive, internationally working researcher and anatomist Hermann Schaaffhausen from Bonn was also able to examine the 16 skeletal elements. Three years before the discovery of the Neanderthal he had published a script with the title "Ueber Beständigkeit und Umwandlung der Arten (On the constancy and transformation of species)". He was thinking along the same lines as Charles Darwin who, after long preparation, finally published his work "On the Origin of Species" in 1859. Against this backdrop, the Neanderthal find sparked a scientific, socio-political and religiously-philosophical discussion without parallel: if a fossil man existed and had developed along the same rules as other mammals, then we don't need a Creator – this was plain heresy for many of Darwin's contemporaries.

The Neanderthal came at just the right time and was not forgotten like earlier fossil human finds. Scientific support came primarily from England. Celebrities such as Charles Lyell and Thomas Henry Huxley paved the way for the Neanderthal to a fair discussion in Europe. The find from the Neander Valley became world famous. Since 1877, the Rheinisches Landesmuseum Bonn has been in possession the original Neanderthal after having prevented its sale overseas. Today, the most prominent exhibition piece is kept available for international research in Bonn. Continuing in this tradition, the Neanderthal has been subject to new comprehensive scientific examinations under the leadership of the author and, currently, 26 researchers from 18 different institutes, since 1991.

The site itself was not as lucky: The romantic Düssel Valley, which had been frequently visited by artists of the Düsseldorf art school, was destroyed so completely by the quarry that in 1900, the location of Kleine Feldhofer Grotte was already forgotten.

So Fuhlrott's conclusion from 1859 was to remain true for another century: "These circumstances can explain why only the skull calotte, a substantial pelvic fragment and only the larger bones of the probably complete skeleton were preserved and the smaller bones such as the facial bones and the vertebrae were not recognized in their loam shell and disposed of with the debris."

The find's fame continuously reflected back upon the Neander Valley and helped bring about the foundation of the Nature Conservation Society of the Neander Valley in 1920. Six years later, a bronze plaque decorated the last remains of the, once so proud, Rabenstein cliffs and in 1937 a small museum was opened some distance from the site. The limestone mining on the southern bank of the Düssel came to an end after the Second World War and the archaeologically interesting part of the old quarry disappeared under an automobile scrap yard. Excavations by the University of Cologne from 1983 to 1985 could not shed light on the old course of the river or the appearance of the valley nor did they lead to the rediscovery of the old cave sediments from 1856. Instead, they came to the identical conclusion, the loam sediments must have been completely removed from the environs of the site.

In 1997, after intensive research, Jürgen Thissen and the author attempted one last effort to find the site. During an excavation by the Rheinisches Amt für Bodendenkmalpflege, Bonn, a stump of rock cliff that was probably kept as a natural protective barrier for the quarry against possible flooding was located. The fillings from two caves were found in front of this stump of rock cliff. Due to the position of the sediments on the southern Düssel river bank, the sediments could be identified as originating from Kleine Feldhofer Grotte, the cave in which the Neanderthal was found, and the neighbouring "Feldhofer Kirche". During the first rediscovery campaign, numerous stone artefacts, faunal remains and human bones were recovered. These led to the continuation of the excavation in the year 2000.

The find spectrum from the overlaying quarry debris layers and the two sediment cones ranges from modern day to the Middle Palaeolithic. Separating the interlocking fillings from the two caves presented a big challenge. The application of the three dimensional geological programme GoCAD (S. C. FEINE, Tübingen) made it possible to separate the sediments and assign them and the finds they contain to the two caves. The Upper Palaeolithic finds made from lithic and organic materials originated from Feldhofer Kirche, while the Middle Palaeolithic forms and bone fragments from Neanderthals were assigned to Kleine Feldhofer Grotte. The basis of this success were the three dimensional measurements of the individual finds. This had been heavily criticized by others because of the secondary deposition of the material.

The youngest finds, analysed by U. Francke, Bonn, come from the time when the quarry was still in operation. The remains of water bottles and iron pieces, among these a heavily used cleaver, are the first archaeological evidence for the destruction of the romantic Neander Valley during the industrial revolution. The fragments from wine jugs and a colourfully decorated small bowl are not much older; these are most likely evidence for the parties of the Düsseldorf art school or other day-trippers in the early 19th century.

Next to these finds it was possible for the first time to associate stone tools to one of the caves of the Neander Valley. The younger material, which originated from Feldhofer Kirche, was assigned to the Gravettian / Perigordian V, a period that was previously not well represented in the Rhineland. The Neander Valley site and Bilzingsleben in Thuringia, another significant Gravettian site, which was wrongfully overshadowed by an overpowering fossil human, represent the northernmost Gravettian sites. On the one hand, the forms in the Neander Valley represent a connection to the Belgian sites and on the other, also clearly show the relationship to the eastern Gravettian. Functionally, the inventory can be defined as a hunting camp.

This definition is supported by the projectile fragments made out of organic materials (FEINE 2006). The raw material spectrum encompasses a number of different materials that, for the most part, have very good knapping qualities. A distance of up to 30 km can be demonstrated; the cores were predominantly decortified and prepared outside of the cave. Only the flint units were prepared to a larger extent in the cave.

90 % of the Upper Palaeolithic tools were made out of this raw material. Special rarities are a few artefacts made out of fossil wood that originate in the Rhine terraces. It is probably that the aesthetic aspects were decisive for the choice of this material.

The Middle Palaeolithic tools are forms of the Micoquian / Keilmessergruppen. The Levallois method could also be identified. The above average number of small round scrapers of the Groszak type is striking. The small, Upper Palaeolithic looking component is also known in lower quantities from other Micoquian sites such as Kulna Cave in the Moravian karst and Sesselfelsgrotte in Bavaria (HILLGRUBER 2006). The type fits into the picture of the progressive and variable tool spectrum of the Neanderthals which we already find in the OIS 5 sites Rheindahlen B1, Tönchesberg 2B or Wallertheim D. These inventories also proved that the development of progressive tool types in Europe was independent of the influence by the anatomically modern humans, who did not migrate into Europe before OIS 3. These ensembles make it more and more obvious that the Neanderthals knew how to master specific challenges by modifying their repertoires.

The Middle Palaeolithic raw material spectrum is dominated by flint variants. The local quartzite is also significant. The raw material units were predominantly prepared elsewhere before they were brought to the site. A maximum distance of up to 30 km can also be demonstrated for these materials. However, a significantly larger, but not substantiated, catchement area e.g. in the adjoining northern distribution area of Baltic flint, can not be disqualified for the Middle and Upper Palaeolithic finds.

Another peculiarity of the Middle Palaeolithic inventory are the tools made out of organic materials. These are retouchers made out of massive long bone splinters that have parallels to the Neanderthal sites Salzgitter-Lebenstedt and Kulna Cave (FEINE et al. 2006).

The use of fire is proven for both periods by the number of burned bones.

The 70 identified human skeletal remains from the excavations in 1997 and 2000 have special significance. Without exception, these can be identified as characteristically Neanderthal elements, as far as they are diagnostically relevant.

Three pieces can be fit without a doubt to the skeleton of the Neanderthal type specimen: A left lateral femoral condyle fragment, a left zygomatic bone and a right temporal bone fragment.

A number of other pieces probably also belong to this individual. The preservation and the distribution of the bones from the entire body suggest an intentional burial. Multiple of the newly discovered skeletal elements are doubles of the elements present in the man from 1856. They prove that an additional adult (female?) Neanderthal was present. A mixing of the two individuals during the unprofessional recovery of the original bones can be ruled out. The type specimen is definitely made up of the bones from a single individual. Two pieces that probably stem from a sub adult individual suggest that at least one non-adult individual was present as well (SMITH et al. 2006). AMS radiocarbon dating on the type specimen and the second individual, carried out by G. Bonani, Zurich, delivered values of 40,000 BP, which places these finds among the youngest Neanderthals in Central Europe.

Neanderthal 1 has been examined with macroscopic, endoscopic, radiological and microscopic techniques to collect information about deficiencies, illnesses and injuries. The fracture of the left arm and the remaining handicap could also be diagnosed anew. The type, spectrum and severity of the illnesses and the state of the healing process suggest that this man was considerably supported by members of his group. Since the age at death was determined to have been 40-42 years, the group had to care for him and compensate for his handicap for many years (SCHULTZ 2006). The man from Kleine Feldhofer Grotte, together with a few other Neanderthal finds, sheds light on these people's social and welfare system, which is still largely unknown.

All the skeletal remains from 1856, 1997 and 2000 were scanned with computer tomography and microCT (T. M. Buzug, Remagen / C. P. E. Zollikofer and M. S. Ponce de León, Zurich) for medical diagnostic purposes as well as for the construction of stereo lithographs and for later computer supported reconstruction.

The Neanderthal research project also made it possible for the first time to shed light on the question of the genetic degree of relationship between Neanderthals and today's people. After intensive research, a bone sample for DNA analyses was taken from the right humerus of the 1856 skeleton.

In 1996, the analyses of the hypervariable region 1 of the mitochondrial DNA by M. Krings and S. Pääbo, Munich, delivered the first Neanderthal DNA sequence ever. The Neanderthal mtDNA sequence showed significant differences to the mtDNA of living humans. This was judged to be evidence against a genetic contribution of Neanderthals to the gene pool of today's people. Analyses of the hypervariable region 2 of the mtDNA of the type specimen as well as the examination of ten additional Neanderthals confirm this first conclusion. The second individual from our excavations is also well preserved and delivered the fourth Neanderthal DNA sequence (S. Pääbo and D. Serre, Leipzig). It has been discussed whether a genetic contribution by Neanderthals to the DNA of the following modern humans took place but the traces where lost in the past 30,000 years. In order to answer this question, an analysis of Upper Palaeolithic human remains is necessary. However, contamination with modern DNA presents an omnipresent problem.

In summary, the newly examined find from 1856 and the new finds from the rediscovered sediments from Kleine Feldhofer Grotte and the neighbouring Feldhofer Kirche have delivered much new information about the site, the people who used to live there and to the Neanderthal species in general. The investigation of these finds from the Neander Valley is not at an end. Some of the examinations were started but could not be completed, due to a number of circumstances, in time for this anniversary. These include for example, the dating of the artefacts made out of organic materials, special investigations of the Neanderthal teeth, investigations into the diet of Neanderthal 1 and 2 using stable isotopes as well as the analyses of cut marks on the Neanderthal 1 and 2 skeletons. New possibilities such as the core DNA analyses on the 1856 find, are being developed further. The type specimen once again takes on the role as the scientific pioneer.

Who knows what results the 200th anniversary of the discovery of the Neanderthal type specimen may bring?

Translated by Iris Trautmann M. A., Tübingen

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Just published:

A monograph on the rediscovered sediments from the Feldhofer Grotte and new finds from the type locality of the *Homo neanderthalensis*

RALF W. SCHMITZ

Neanderthal 1856 – 2006

360 pp. Rheinische Ausgrabungen 58,
Mainz (Philipp von Zabern).

Abstracts of Posters

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1

Neanderthal and Modern Humans

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The southern Caucasus is a prime setting in which to model Neanderthal-modern human interactions. The region occupies an intermediate position between Europe and Asia that is bounded to the west, north, and east by the Black Sea, the Caucasus Mountains, and the Caspian Sea, respectively. As such it represents a geographic cul de sac where individuals and cultures in contact have limited room to maneuver as they compete for resources. In such settings, where movements and opportunities are largely circumscribed by the surrounding landscape, there is less opportunity for significant temporal overlap among competing populations, especially if one population develops a major technological, biological, or social advantage. This poster presents recent archaeological data from Ortvale Klde, a late Middle-early Upper Palaeolithic rock shelter in the Georgian Republic. These data indicate that local Neanderthal populations, like their cousins to the north, were adept hunters who targeted adult Caucasian tur (*Capra caucasica*) during seasonal aggregations of this species. The Neanderthal occupation of the region came to an abrupt end approximately 36ka (uncal BP). The Upper Palaeolithic populations who replaced them from the south targeted adult tur in the same frequencies thus it is not clear how or if their toolkits of bone points and backed bladelets provided any clear technological advantage. Raw material studies suggest that early Upper Palaeolithic populations possessed a cultural advantage that allowed the establishment of larger extended social networks and the exploitation of larger territories. The simultaneous appearance of archaeologically similar Upper Palaeolithic groups elsewhere in western Georgia and in the northwest Caucasus demonstrates that this process of replacement was rapid, and widespread beyond traditional geological and hydrological barriers to Neanderthal mobility. Unlike other parts of Eurasia, data from the Caucasus suggest that developments in the social realm of Upper Palaeolithic societies allowed these populations to rapidly replace Neanderthals, with little if any significant temporal overlap or interaction.

2

Population of North Africa: regional evolutionary continuity

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North Africa has been inhabited by many prehistoric civilizations since high antiquity. Furthermore several key sites permit us to follow the morphological and cultural evolution of the human fossil (Aouraghe, 2006).

The morphometric study of the Maghrebian human fossils shows that a mosaic evolution took place locally, developping from the oldest *Homo erectus* which surely came from Eastern Africa more than one million year ago up to the archaic *Homo sapiens* (Mousterian) of Jebel Irhoud then to anatomically modern (Aterian) *Homo sapiens* and to modern humans (Iberomaurusian). Indeed, a series of well preserved Maghrebian human remains was identified presenting a mixture of archaic and derived characters. For example, the cranium of the fossil of Salé (Morocco) and the craniums of the fossils of Jebel Irhoud (Morocco) present primitive characters reminiscent of its ancestors *Homo erectus* “Atlanthropus” (general robustness, strong relief supraorbital, teeth of big size, broad face, low and flattened [Hublin 1991]), and advanced characters which announce Aterians and probably Iberomaurusians (morphology of the occipital and frontal bone, the absence of the prognathism, the presence of a chin).

The Aterians exhibit in turn archaic features that recall Archanthropians (Ferembach, 1986) and advanced characters announcing Iberomaurusians; thus confirming a local evolution in the Maghreb (Debénath 2000).

North Africa would be thus considered to be an example illustrating the hypothesis of regional continuity in the evolution of *Homo erectus* towards *Homo sapiens* (Ferembach 1989; Hublin 1991).

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3

The Krapina femora 213 *Fe*. 1 and 214 *Fe*. 2: the study of skeletal activity and adult age markers

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The study of the Krapina collection (Riss-Wurm, Croatia) has been undertaken within a project of data collection of skeletal markers of activity (morphology and alterations of the enthses and joints, alteration of teeth) and of adult age (persistency of epiphysial lines) in different prehistoric skeletal series using standardized methods prepared by our research group. The Krapina collection, consisting in hundreds cranial and postcranial fragments and teeth, is one of the most important skeletal collections of neandertalian remains. It has already been the object of many works with the aim of studying the phylogenetic, biological and behavioural aspects of this neandertalian population. Nevertheless, the study of skeletal markers of activity and of adult age using standardised methods, and thus the possibility of comparison of homogeneous data, will shed new light in the genetic vs environmental interpretation of the features observed and in the investigation of the biological and behavioural aspects of Middle Pleistocene populations.

In this work we will show the observations concerning the enthuses, some articular features and adult age markers of the 213 *Fe*. 1 and 214 *Fe*. 2 femurs. In particular, the specific morphology of the gluteal tuberosity (insertion site of the *m. gluteus maximus*) and other entheseal characteristics are interpreted in a functional key, while the persistency of the epiphysial line and the presence of some osseous features (Allen's fossa, lower entheses development) in one of the two specimens (214 *Fe*. 2) allow us to hypothesise that it has belonged to a young-adult individual.

4

Management of Palaeoenvironmental Resources and Exploitation Technology of Raw Materials in the Middle Palaeolithic Site of Oscurusciuto (Ginosa, TA, South Italy)

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The Authors introduce some preliminary data regarding the lithic industries and the faunal remains discovered in a Middle Paleaeolithic site: the Oscurusciuto shelter, situated in the gravina of Ginosa, with several layers of anthropic frequentation. From 1998 the deposit, which has an amplitude of approximately 60 mq and a thickness of nearly 5 m, has been object of systematic excavations by the Departement of Environmental Science "G. Sarfatti" of the University of Siena. This study exposes the technological and typological analysis of the lithic material from the US 1 and from a sample area of US 4. The ungulate remains, characterized from the prevalence of *Bos primigenius*, show a selection of skeletal parts related to the exploitation of long bones for the extraction of marrow and the probable use of epiphysis and articular bones as fuel. About the lithic industry, in addition to the retouched elements, the entire range of the flaking products is present, showing that the entire reduction sequence has been carried out on the site, exploiting the jasper pebbles collected from the bed of a near channel. The study of the technological criteria indicates a substantial similarity between the two US considered, and the amount of cores has allowed the individuation of the operational chains employed in the knapping activity. In both the US the adoption of the unipolar modality of levallois technique is prevalent: the chronological difference between the two US is marked by the presence, even reduced, of cores exploited through discoid technique in unit 4, and by the complete absence of such technique in unit 1. Through the technological study it has been possible to find the relationship between the knapping sequences and the morphology of pebbles used. The results pointed out by the typological approach confirm the C14 date obtained for US1 (38.500±900 BP) and the cultural attribution of the lithic complex to a final phase of Middle Palaeolithic as a typical Musterian rich of scrapers.

5

Growth and Development of the Upper Limb and Shoulder in Neandertal Juveniles

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The pattern of growth and development in fossil species has been a focus of paleoanthropological research for the last two decades. Efforts to better understand the genetic component of adult morphological characteristics necessitates examining juvenile remains. Neandertals continue to be a dominating interest to paleoanthropologists. Adult Neandertal morphology has been examined in detail and Neandertal juveniles are increasingly becoming the focus of major research. This study examines the growth and development of typical ‘Neandertal’ morphological characteristics of the shoulder and upper limb. These characteristics include the axillary border of the scapula, the development of the deltoid tuberosity, the flattening of the humerus, the curvature of the radius, and the robusticity of the upper limb. These features were examined on the Neandertal juveniles from Krapina, Dederiyeh, La Ferrassie, Teshik-Tash, Kiik Koba, and Le Moustier. The aim of this research was to determine at what age Neandertal juveniles develop the morphological characteristics typical of Neandertal adults. This project revealed that some characteristics are present early in ontogeny, suggesting a strong genetic component for the characteristic, while others develop much later in juveniles, suggesting biomechanical forces may be responsible for the morphology in older juveniles and adults.

6

The diet of Italian Neanderthals: an overview

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Data about subsistance strategies of the Italian human populations during the Middle and Upper Palaeolithic are compared. *Homo neanderthalensis*, evolved from the European populations of *Homo heidelbergensis*, shows some specialistic morphological traits. Also in the alimentary behavior this hominid species seems to be specializated. Anatomically modern humans of the Italian Upper Palaeolithic seem to differ from the alimentary behavior that characterized neanderthals: the diet is more varied, with a greater contribution from fresh waters alimentary resources (molluscs and fishes, especially during the Gravettian and more recent periods.

7

Barbas I C\'4 sup (Creysse, France) and the \”Trifacial\” knapping concept: technical characterisation, geographical and chronological localisation, evolutionary hypothesis

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The Meridional Acheulian – cultural entity of southwestern France – was regarded a long time as a technical unit characterized by the presence of atypical handaxes, of cleavers, of Upper Paleolithic tools and by the weakness of the Levallois index. However, this definition was not single and other criteria, similar or different, were taken into account to describe this \»Acheulian\». Finally, a study of the various definitions as well as a technological analysis of several assemblages showed the difficulty of comprehension of those by the typological method and the presence, in fact, not of a concept of bifacial shaping, but of a concept called \»Trifacial\». This structure corresponds to an original exploitation of the block: it is organized according to three faces allowing a twofold function of flaking and shaping. This matrix can thus be used as a core (main use) but also as a tool. The analysis of the material of Barbas I C'4 sup (Creysse, France) allowed to recognize once more the \»Trifacial\» concept in Bergeracois, showing the development of this one in the area. The comparison between various assemblages with \»trifaces\» made it possible to highlight several methods of initialization and production, supporting an independence of the concept with morphology of the raw material. Contrary to certain assumptions, \»Trifacial\» thus corresponds to a cultural production, which is not determined by the environment. The frequency of the concept in Bergeracois leads us to consider the existence of a \»trifacial\» technocomplex, characterized by a relative geographical unit but also by a very particular chronological criterion. Indeed, the five available dates are spread out over at least 260 000 years. This phenomenon could be explained by a structural character of the \»trifacial\» matrix. Its evolutionary potential is saturated and its structure is hyper-specialized (\»hyperthelic\»): so its relatively frequent appearances and disappearances are noticed in the technical evolution according to external changes. Moreover, its coexistence with assemblages with both bifacial shaping and low-elaborated debitage structures since at least the isotopic stage 9 could show the invention of different solutions for the same aim: to associate shaping and flaking structures. \»Trifacial\» is an answer by producing both shaped and flaked blanks, from the same structure. However, the bifacial shaping does not correspond to a hyperthelic structure: this one is known as a \»concrete\» one and presents thus a definitely higher evolutionary potential than the \»triface\» one. So, he owns a better capacity of adaptation to external changes, contrary to the \»trifacial\» matrix. That may explain its success and its longevity compared to other concepts.

8

LATE NEANDERTHALS AND THE FIRST MODERN HUMANS IN THE SWABIAN JURA

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The caves of Swabian Jura provide one of the best records available for the beginning of the Upper Paleolithic in Europe. The available evidence indicates that Neanderthals produced all of the region's Middle Paleolithic assemblages. Around 40,000 calendar years ago modern humans arrived in the upper Danube region. At this time we see the first Aurignacian assemblages, which are characterized by numerous innovations in the areas of lithic technology, organic technology, personal ornaments, figurative art and music. This shift in the archaeological record is dramatic. The sites in the Swabian Jura do not document contact between Neanderthals and modern human populations in the form of interstratification or hybrid assemblages. At all sites, Middle and Upper Paleolithic horizons are separated by deposits lacking artifacts.

While Neanderthals practiced "low impact", low population density strategies, modern humans extracted more resources from the environment and lived in higher population densities. This can be seen in the cultural debris from the Swabian cave sites and in the form of shifts in technology that document new methods for extracting resources from the Pleistocene environment. The demographic success and increased occupational intensity of modern humans helps to explain both the extinction of Neanderthals and somewhat later the extinction of cave bears. Here we present the data from Swabia and consider the implications of these data for modeling the spread of modern humans and the extinction of Neanderthals.

9

The level 14 of Cave Bajondillo and the end of the Middle Palaeolithic in the South of the Iberian Peninsula

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Cave Bajondillo is a rock shelter tufas in the south of Iberian Peninsula with the following archaeological sequence: a) Middle Palaeolithic (six strata: 19 to 14); b) Upper Palaeolithic (Aurignacian, 11; Gravettian, 10; and four Solutrean, 9-6); c) Neolithic (2-1); and d) Other strata which are difficult to classify chrono-culturally due to the scarcity of archaeological material in them (12-13 and 5-3).

The substitution of the Mousterian techno-complex for the industries that can be assimilated to the Early Upper Palaeolithic takes place in Bajondillo by means of superposition: Bj/14 (Mousterian rich in notched and denticulated tools) and Bj/11 (techno-typological features - cores, debitage and tools - correlate to a great extent to those with characteristics typically attributed to the Aurignacian industry.

The scheme of production of the Bj/14 lithic sample is obtained according to norms where the Levallois récurrent centripetal and discoids methods are very frequent. In the typological section, always in essential indexes, we have a very low Group II (IR<15%), characterised by the loss of diversity with regard to the underlying assemblages and the increase of the marginals. The Group-III displays, throughout the Bajondillo's Mousterian series, a gentle but continuous rise which, in the case we are dealing with, approximates 10%, with a IB>IG. One fact must be born in mind, throughout out the whole UP section of the site, the burins are only surpassed by end-scrapers in level 11 (Aurignacian). This tonic is maintained in the Mousterian packet, maintaining in addition a IP>IG proportion. Whilst the denticulates obtain on their own levels in excess of 14.9 %, the Im-d exceeds slightly 39.4 % of the material retouched.

The chronological position of the Middle Upper Palaeolithic substitution has been eventually analysed in Bajondillo by means of AMS and TL datings applied to the series from Bj/11 to Bj/14.

The chronological and techno-typological data obtained from Bj/11 permits us to draw the line which marks, in AMS terms, the incorporation of the Aurignacian techno-typological novelties in the Southern part of the Iberian Peninsula in the chronological period 35.5-31 ky. B.P.

This age confirms the lateness of the Southern Mousterian. However, it considerable shortens the supposed tardiness in the arrival of the news techniques of the Upper Palaeolithic to this particular geographical area, compared to that of the sites in the northern of Iberian Peninsula thus reducing the chronological range to between 3.5 and 7 millennia.

As far as the technological substitution is concerned, in the Bajondillo Cave one can only speak of a rapid, abrupt substitution without any apparent techno-typological lendings.

The first results of the use wear analysis indicate that the tools were used mostly on the striping of the flesh, on the processing of fresh leather and on wood working. The slight development of the tool marks indicates that we are facing working processes that took place in a short period of time. While a larger number of pieces is not available for analysis, we think this fact may be related to very specific activities on subsistence, on the first tasks of leather preparation, and on the maintenance or repair of some wooden artefacts.

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The lower Weichselian Neanderthal parietal bone of Warendorf-Neuwarendorf

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The specimen MKZ 4013, 123 (katalog no. of the Westphalian Museum of Archaeology in Muenster, Germany) was found by Mr J. Gora from Warendorf-Neuwarendorf in 1995. The find was recovered from an artificial lake in a gravel pit (deep sand extraction) which lies geographically at 54° 58' N, 7° 7' 8'' E. The anthropological research by Czarnetzki (Czarnetzki, 1998) revealed that it is a fragment of a right parietal bone (*Os parietale dexter*) of a *Homo neanderthalensis*, showing the typical features of Neanderthals. This specimen from Warendorf shows inflammatory structures. On the one hand the calvarium shows an osteomyelitis, which can be made out by an irregular structure of the surface of the skullcap together with fine funnel-like depressions and fine impressions of vessels, which grow larger towards the middle of the skull. One cause for the osteomyelitis might have been a trauma of the full thickness skin of the scalp with subsequent infection. On the other hand very fine impressions of vessels on the inside of the skull fragment pathognomonically point towards a nonspecific meningitis. In all likelihood it is possible that meningitis and osteomyelitis are linked. Whether the individual died of the meningitis cannot be determined. Neither can it be said which was the primary infection. On top of that a hypervascularization at the *Sinus sagittalis* in front of the *Foramen emissarium parietale* was discovered, as well as two notches, which were caused by benign tumours (Czarnetzki and Trellisó Carreno, 1999). The age of the individual at the moment of death was determined to be between twenty and thirty years, but the osteomyelitis probably caused the process of maturation to accelerate.

The anthropological research was accompanied through autumn 1997 by DNA-analysis. It was supported by pivotal results. The isolation of ancient DNA (fDNA) out of a sample of 2 cm^2 of the posterior part of the parietal bone (*Os parietale*) was carried out by deciding techniques of extraction and cleaning that were developed especially for the extraction of fDNA out of osseous material (mix & clean technique). The subsequent DNA/DNA-hybridization was successfully carried out on the sample of Warendorf-Neuwarendorf as well as with the needed control samples. It resulted in a classification to the species *Homo neanderthalensis* (Scholz et al., 2000).

The geological research on the sequences near the lakes in gravel pits at Warendorf showed that the stratigraphical units originate from the Weichselian glacial (OIS 5e to OIS 2). The probability that neanderthal man stayed in the Muensterland area during the cold phases of the last glacial seems rather small. It seems more likely that they imigrated to Muensterland during warm climatic periods of the Weichselian glacial, probably in an earlier phase. As well as the hominid *Os parietale* fossil remains from *Ovibos moschatus, Mammuthus primigenius, Rangifer tarandus* and *Dicerorhinus hemitoechus* were found in the same site, along with stone artifacts.

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Czarnetzki, A. and Trellisó Carreno, L. 1999. Le fragment d'un os pariétal du néanderthalien classique de Warendorf-Neuwarendorf. L'Anthropologie, 103: 237-248.

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11

The most northern Neanderthals up to now from Sarstedt, district Hildesheim, North-West Germany

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On the surface of gravel pits located in the western part of the Sarstedt village, 12,5 miles of Hannover 3 skull fragment were discovered by Ortrud and Karl-Werner Frangenberg in 1997 and 1999. The Fragments originate from layers that must be elder than Holocene time (date postquem) and younger than Holsteinian time (date antequem).

Together with these bone fragments there were found different artefacts like handaxes, bifacially worked scrapers, small oval handaxes of erratic flint exhibiting various degrees of patination and gravel contusions. These artefacts confirm the presence of late middle paleolithic cultures at this side. It remains unclear whether the finds are part of a single archaeological assemblage, originating from various more or less concurrent and/or nonconcurrent sites, or derive from concurrent and/or nonconcurrent so-called "off-site" activities. The tools were made of grey erratic flint. These features indicate different taphonomic histories for the various artefacts. Even though tool typology indicates a Middle Paleolithic context, the finds do not contribute to a more precise dating of the recovered human remains. They prove only the presence of humans at this side through Middle Paleolithic times.

Geologically the dredged-up gravels at the point, where the skull fragments and artefacts were collected, originate from the lower terrace sediments accumulated by the Leine River and its tributaries during Pleistocene age. This was just at the end of the Saalian complex, but mainly in any case through the Weichselian glacial period. The lower terrace sediments are covered by a thin layer of flood plain loam of Holocene that will be removed before starting of dredging. It is supported by fine sands presumably of Saalian age. A former channel in the solid rock of cretaceous age forms normally the basis of the body of the lower terrace.

The skull fragments are defined by their special well known morphological features that can only be observed at skulls of Neanderthal man. The Sst III fragment of a left parietal is characterised by its special impressions of the posterior ramus of the middle meningeal artery (Ramus posterior arteriae meningeae mediae) and its continuous curvature beginning at the sagittal suture (Sutura sgittalis). The Sst II is a fragment of an occipital bone (Os occipitale). The features of this fragment that are typical for its attribution to Neanderthals are the continuous torus (i) and the typical occipital bunning (chignion) (ii) while the suprainiac fosse (Fossa suprainiaca) and the strongly indented lambdoid suture (S. lambdoidea) are common features of different phylogenetic stages of human development up to modern man. The SstI fragment of a right temporal bone is characterised by an admixture of typical Neanderthal-like features and those of an earlier developmental stage of humans. This admixture will be the reason for to call it "a child of the ancestors" of Neanderthals. The adherent original sediments argue not against the provenience from layers of the Saalian complex.

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12

Neanderthals and modern humans of cave sites from north-western Croatia and Slovenia

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Amongst other Slovenian and Croatian cave sites the findings of humans, large mammals and artefacts from the Potocka zijalka (1,630 m a.s.l., Slovenia) and the Vindija cave (275 m a.s.l., Croatia) will be compared. The 12 m thick stack of sediments in Vindija Cave can be divided in 13 layers designated from unit A (youngest) to unit M (oldest). The interest at the Vindija cave is focused at the layers G3 (Mousterian) and F (Aurignacian). The remains of the Potočka zijalka show a consistent package which can be dated into the Aurignacian. The comparison and comprehension of the new investigations of the excavations from 1997 to 2000 (Pacher et al. 2005) and the the Vindija cave (Karavanic 2000) will give a good overview from climatic environmental requirement in the Upper Pleistocene between 35.000 and 26.000 years BP.

Both sites contain bone points as well as stone tools. These sites are known as one of the best dated sites of Eastern Europe.

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Karavanic, I., 2000. Olschewian and Apperance of Bone Technology in Croatia and Slovenia. - In: Orschiedt, J., Weninger, G.C., (Hrsg.): Neanderthals and modern humans - Discussing the Transition Central and Eastern Europe from 50.000-30.000 B.P., Mettmann.

13

Symbolism in Neanderthal man. The Krapina human remains

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According to some Authors the symbolism would be characteristic of Homo sapiens anatomically modern. This manner of thinking reflects a very restrictive conception of the symbolism that would be limited to the artistic and funerary manifestations of the Upper Palaeolithic. In our opinion the symbolic capability could be recognized in the results of the human activity when they raise a meaning that goes beyond the immediate application.

The symbolism is capacity to give a meaning to a sound, a tool, and behaviour. Together with the human ability to plan, symbolism is expression of culture. Three type of symbolism may be recognized: functional (in the results of the technology for tool making and for organizing the territory), social (in the language and in the social communication), spiritual (when the behaviour is not related to adaptive strategies, as funerary practices, art, religiousness, no opportunist expressions, etc.).

In the Neanderthalians as in their ancestors are present different expressions of symbolism. The tool making corresponds to different projects and has a meaning in the context of their lifestyle (functional symbolism). Many Authors admit kind of language to put in relation to technological and social development (social symbolism). References of spirituality emerge from the activities related to the burials as well as other activities as the shell collection, the signs intentionally produced on ornamental objects, whatever would be their origin. The attention towards the corpse may be expressed in different behaviour as the burial or the treatment of the corpse (dismemberment, use of ochre, etc.). Regarding what above-mentioned, the remains of Neanderthalians of Krapina, even though the bones are highly fragmentized in relation to post depositional events, show some features that recall some symbolic meanings.

Many Authors disagree about the interpretation of some features of the Krapina collection as the bone accumulation, the bone breakage, and the cutmarks on the bones. The Krapina collection is still a controversial case as for the recognizing of intentional human intervention and meaning (cannibalism vs. secondary burials) of those features. Our observations on some cutmarks of the Krapina collection compared with those of some modern skeletal collection may be giving a contribution on this debate.

14

Territorial mobility of Abric Romaní level M Neanderthals groups (Capellades, Barcelona, Spain)

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The Abric Romaní site is located in the northeast Iberian Peninsula, 50 km from Barcelona. The rock-shelter is situated over 317 m (above sea level) in a travertine cliff on the right bank of the Anoia river, which is a tributary of the Llobregat river. This river passes by the Capellades locality, excavating a narrow gorge known as the “Cinglera del Capelló”. This corridor crosses the mountain range “Cordillera Prelitoral”, and is considered as a natural passage between the inland and coastal Catalonia regions. This strategic location of the site provides to hominids the possibility to exploit a great variety of biotopes: river beds, plain and plateau, benefiting from a very rich environment. This fact is shown by the continuous presence of humans at the rock-shelter during a long span of time. The site yielded one of the more important and complete stratigraphic sequences of Europe Middle Palaeolithic. Fifteen archaeological levels had been excavated as of today (A to O). These levels appear as thin layers interbedded between the sterile travertine platforms. This sequence has been dated by U-series in between 70 and 40 ka BP. Except for the uppermost level (A), which is attributed to the Early Upper Palaeolithic, the rest of the archaeological horizons correspond to the Middle Palaeolithic (B to O). Pollen analyses have revealed five climatic phases, ranging from the milder conditions at the bottom to the interstadial climate at the top, correlated with the Hengelo interstadial. It is, consequently, a key site for human's behaviour studies among Neanderthal groups. This paper presents the results of studies on resource procurements (lithics and animals) and on the territory use by Neanderthal groups, through the example of level M dated from about 55 ka BP. The results of interdisciplinary analysis of lithic (including raw material studies and technology studies) and faunal assemblages (zooarchaeology and taphonomy) suggest that the resource procurement and management is focussed on a local and semi-local exploitation in a geographic area of about 20 km around the rock-shelter.

15

The Neandertal Skull Cap from the East Eifel Volcano „Wannenköpfe" near Ochtendung, Rhineland-Palatinate, Germany – Discovery and Initial Results of a Comparative Morphological Analysis

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Parallel to the industrial lava-mining on the East-Eifel quaternary vulcanos the Landesamt für Denkmalpflege in Koblenz has during the last 20 years documented numerous findings of hunting and settlement activities from Neandertals in the crater-fillings.

A first and so far unique find of neandertal osseous remains were discovered in 1997 by one of the authors (AvB). Close to the village of Ochtendung in the north of the state of Rhineland-Palatinate three larger fragments from a skull cap as well as three associated stone tools whereof one, a silex burin, was made of Maas-Flint were found.

The well investigated geology and the well-known sediment deposition mechanism point to the conclusion that the remains were deposited during the early Saale glaciation about 160.000 years B.P. The bony fragments and the stone tools were found without any archaeological context. A first preliminary analysis was done (Condemi 1997, von Berg et al. 2000). We present in the following a more complete study (Flohr et al. 2004).

Clear traces of secondary treatment on the inner lamina and on the edges of the skull cap allow the conclusion that the calotte was used as a kind of artifact.

A metopic suture is present and all the sutures are nearly closed. The thickness of the skull vault is remarkable. It measures 8,0 mm at the Bregma and 11,0 mm at the parietal tubera. A comparison of the thickness with other Neandertals and *Homo erectus* individuals supports the observation that the Neandertal individual from Ochtendung lies in the upper range of variation of the "Classical Neandertals". On the other hand, it is also in the lower range of variation of the Asiatic *Homo erectus*.

The sagittal contour shows that the calotte from Ochtendung is extremely flat in the parietal areas. The curvature is comparatively regular when compared to male "Classical Neandertals" in which a stronger bulging can be observed behind Bregma (e.g. La Chapelle, Spy 1). The closest similarity in this particular morphological feature between Ochtendung and the other Neandertals can be seen in the skull of La Quina 5. The frontal area of Ochtendung appears to be stronger and more pronouncedly rounded when viewed in sagittal contours. It is thus clearly more rounded when compared to other skulls of Neandertals. A similar curvature can be seen in the calvarium of Petralona. The transversal profile shows clear similarities with the calotte from Ochtendung with the calvaria from La Chapelle and Monte Circeo.

The find from Ochtendung is an important enrichment in the European fossil record, specially for the transitional period from European *Homo erectus* to the "Classical Neandertal", a period where just very few fossil remains exist. The morpholgical features of the Ochtendung specimen could support the wide accepted theory that the Neandertal developed from the Homo heidelbergensis.

Concerning the thickness of the skull cap, a differential diagnosis of pathological conditions like anemia or inflammatory processes in the diploetic bone has to be investigated. Further more, the present knowledge about the shape and morphological variability of the skull vault is limited by the small sample size of existing specimens.

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anderthal Calotte from Ochtendung, Germany. – Hum Evol. 19, 1-8.
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16

The late Middle Palaeolithic in the Verdon Valley (Haute-Provence, south-eastern France)

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Many cavities in the Verdon Valley (South-Eastern France) have been used as shelters by the prehistoric people, for at least 400 ky. The Neandertals occupied some of these cavities, especially in the middle and lower gorges, and sometimes also left a few artefacts at open air spots. Three caves or shelters yielded significant lithic assemblages and allow tracing the evolutionary trends of the technical behaviours: the Baume Bonne cave, the Abri (shelter) Breuil and the Sainte Maxime cave. The faunal remains, often badly preserved, mostly comprise Ibex, Horse and Bovids. It is to be noted that Ursus spelaeus occupied some of the caves in alternation with Neandertals.

The late Middle Palaeolithic, considered as the lithic industrial complex of the typical Neandertals, actually results, in this region, from a gradual evolution of the technology, as shown in the long sequence of the Baume Bonne cave. The Levallois core reduction method punctually appears right from the OIS 8, but starts developing progressively in the second half of the OIS 6, in association with the selection of better quality, exotic raw materials. It becomes a common practice, in the Verdon Valley, from the end of the OIS 5, yet in shares with other less elaborated methods like discoid or opportunistic/direct; this variety of methods may be partly related to the raw materials (good quality flint and quartzite, local as well as exotic, are preferred for the Levallois method). In this technological context, some elongated flakes and blades are produced through uni-bipolar Levallois or semi-turning methods. All the lithic assemblages are rich in scrapers, and this feature was already characteristic of the earlier lower Middle Palaeolithic phases.

Despite the gaps in the settlement records (absence of people and/or erosion), the lithic technology of the Neandertals appears to be in continuity with that of their predecessors. If the Verdon Valley has undergone cold climatic phases due to the proximity of the Alps, its relative closeness to the Mediterranean shore (80 km) and easy accessibility from the Rhône corridor through the Durance valley might have maintained certain continuity in human occupations and technical traditions.

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The level "G" of Las Fuentes de San Cristóbal Archaeological Site (Southern Pyrinees, Spain): Availability of lithic resources and territory management

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The archeological site of Las Fuentes de San Cristóbal is located in the Huesca province, north-eastern Spain. It is situated in between the exterior Axial zone mountains and the Middle Depression of the Pyrenees Chain. This area presents a complex system with wide hidrographic valleys, formed by the Ésera, Isábena and Noguera-Ribagorzana rivers. These characteristics have produced a broad lithological resource to be exploited by hominins. The level "G" is situated above a basal level with pebbles, dated 55.000 ka B.P., therefore it belongs to the OIS 3, but no absolute dates are available at the moment. During this interglacial period the river valleys open new potential areas for procurement of lithic resources. The lithic assemblage of level G has yielded 4.440 pieces, but only 2.199 of them are analyzed and presented in this study. This assemblage is mainly formed by knapping products, and some cores and retouched tools. The main used knapping method is discoidal, and the products are denticulate and side-scrapers tools. The most employed raw material is flint, in its different varieties. It is followed by limestone, porphyry, quartzite, sandstone and, in a lower percentage, lydian stone and quartz. The primary position of all of these lithic materials is located in a "semi-local" area between 9 and 24 km from the archaeological site (siliceous formations), and the secondary position is on the surrounding of the site (alluvial deposits). The study of the lithic resources availability and the territory management brings new data and ideas about the exploitation of high mountain ecosystems by the fossil human communities in the Pyrenees. Key words: Middle Palaeolithic, Neanderthals, Fuentes de San Cristobal, Spain, OIS 3, lithic technology, raw materials, resources management, territorial mobility.

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GIS-gestützte 3D-Modellierung hochweichselzeitlicher Sedimente in Mecklenburg-Vorpommern

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Im Rahmen dieser Arbeit wird derzeit für das Gebiet von der Wismarbucht bis in den Bereich des Schweriner Sees erstmalig ein hochauflösendes, dreidimensionales Untergrundmodell der hochweichselzeitlichen Sedimente im Westteil Mecklenburg-Vorpommerns erstellt. Aufgrund der weitflächigen, jungquartären Bedeckung und seiner zentralen Lage innerhalb der Mitteleuropäischen Tiefebene, ist Mecklenburg-Vorpommern ein klassisches Untersuchungsgebiet glazialer, geomorphologisch definierter Oberflächenformen sowie der zugehörigen Sedimente. Doch nach wie vor stellen sich bei den weichselzeitlichen Ablagerungen stratigraphisch-geologische und paläogeographische Probleme, die durch eine zweidimensionale Erfassung allein nicht lösbar sind. So liegt derzeit kein räumliches Untergrundmodell vor, das größere Teilbereiche der weichselzeitlichen Ablagerungen miteinander korreliert.

Im Zuge dieser Arbeit wird für die weichselzeitlichen Sedimente Mecklenburg-Vorpommerns der Weg der GIS-gestützten 3D-Modellierung beschritten. Durch die Anwendung dieser Technik der Datenaufbereitung und Visualisierung ergeben sich erweiterte Möglichkeiten für die Korrelation einzelner Einheiten. Ebenso lassen sich paläogeographische Randbedingungen wie die Hydraulik der Schmelzwässer in die Modellierung einbinden. Die Visualisierung als 3D-Objekte erlaubt es, Informationen wie Variationen des Sedimentcharakters und deren räumliche Verteilung zu erfassen und miteinander in Beziehung zu setzen. Somit erhalten bislang punktuell bzw. linear erfasste Daten in Form von Bohrungen und flächenhaften Interpolationen als zweidimensionale Karten einen gesteigerten Informationswert.

In dieser Arbeit wird die Verbreitung und Mächtigkeitsverteilung der hoch- und spätweichselzeitlichen Ablagerungen innerhalb des Pommerschen Stadiums dargestellt. Die Sedimentkörper werden in hoher Auflösung (Rasterabstand unterhalb 100 m) in 3D unter Nutzung sämtlicher relevanter und zugänglicher Daten modelliert. Bei Nutzung eines Digitalen Geländemodells (DGM) werden geologische

Karten, bei denen das Holozän abgedeckt ist, errechnet. Die W2- und W3-Sedimente werden innerhalb des Untersuchungsareals korreliert und bislang fragliche Sedimentabfolgen im Untergrund aufgrund der genetischen und räumlichen Zusammenhänge gedeutet. Insbesondere die vielfältigen Darstellungsmodi wie Profilschnitte, 3D-Blockbilder oder Mächtigkeitskarten sind bei dieser Teilaufgabe sehr hilfreich. Aufgrund der 3D-Modelle werden stratigraphische Korrelationen der bearbeiteten Ablagerungen zu solchen der angrenzenden Gebiete (Ostteil Mecklenburg-Vorpommern, Nordpolen, Schleswig Holstein) vorgenommen. Desweiteren erbringt die Massenbilanzierung quantitative Ergebnisse zur glazialen Eintiefung und der Sedimentakkumulation innerhalb des Gletscherbeckens. Anhand von sedimentologischen Untersuchungen werden Aussagen zur Genese und Lithofazies erarbeitet, sowie im Zuge der Kleingeschiebe- und Schwermineralanalyse erörtert, ob Variationen im Gletschereinzugsgebiet angezeigt werden. Die Oserzüge, Gletschertore und die Konfiguration der Endmoränen werden genetisch miteinander in Beziehung gesetzt. Abschließend ergibt sich eine paläogeographische Rekonstruktion des Weichsel-Hochglazials. So werden durch die 3D-Modellierung Paläo-Landoberflächen generiert, die die Vereisungs- und Landschaftsgeschichte im Arbeitsgebiet nachvollziehbar machen.

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High-resolution in situ analysis of O, Sr, Pb and Ca isotopes in fossil human teeth

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Earlier this year, we have started a research program which aims to gain new insights into the life history of ancient humans. Aspects of their diet and migration patterns will be reconstructed though the precise measurement of a suite of isotopic tracers in human teeth. The dentition of every human individual contains a detailed record of the first 14 to 16 years of his/her life with a daily resolution. High resolution, in situ analyses by some of the most advanced analytical instrumentation will be used to unravel this hitherto untapped geochemical archive. Sr and Pb isotope data will allow the reconstruction of annual and lifetime migrations through distinctively different bedrock provinces, Ca isotopes will give a measure of meat consumption and oxygen isotopes will provide a seasonal climatic reference. Prior to the measurement, teeth are cut in halves. Sr, Ca and Pb isotopes are measured with laser ablation inductively coupled plasma multi-collector mass spectrometry. The in-house development of the laser ablation cell resulted in a system with very fast response times which results high resolution isotopic analysis, perhaps bi-weekly in the case of human teeth. The laser track of a high resolution analysis is about 85 ìm wide and 10-20ìm deep. In-house developments on the existing sensitive high resolution ion micro-probe (SHRIMP) permits in situ analysis of oxygen isotopes (in 35 ìm spots) with a precision of better than 0.3‰. All analyses together require minimal sample mass (< 1 mg), the greatest damage to the teeth derive from the cutting width (around 0.1 to 0.3 mm). After analysis, the two halves of the teeth could be glued back together with little visible damage. We have started to analyse a reference sample set from site of Payre, including a suite of herbivores, omnivores, carnivores and humans from the same stratigraphic layer. We will present the results that we have obtained thus far.

20

The occipital bun: Variation, Integration and Homology

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The occipital bun (chignon) is cited widely as a Neanderthal derived trait. It encompasses the posterior projection / convexity of the occipital squama and is associated with lambdoid flattening on the parietal. A 'hemibun' in some Upper Paleolithic Europeans (UPE) is seen by some as evidence for interbreeding between Neanderthals and UPE. However, 'bunning' is difficult to measure, and the term has been applied to a range of morphological patterns. Furthermore, its validity as a Neanderthal autapomorphy, and therefore its usefulness in phylogenetic reconstruction, and its homologous status across modern and fossil humans have been disputed. Specifically, Lieberman et al. (2000) found that bunning in recent humans is correlated with narrow cranial bases, while it is found with wide bases in Neanderthals. They concluded that the cranial integrational pattern responsible for this morphology differs in the two taxa. The integration pattern shown by the UPE is therefore critical in evaluating their proposed evolutionary relationship with Neanderthals.

We present a geometric morphometric study quantitatively evaluating the chignon, assessing its usefulness in separating Neanderthals from modern humans and its degree of similarity to UPE 'hemibuns'.

326 modern human crania and several Middle and Late Pleistocene European and African fossils were measured by one of us (KH), as 3D coordinates of closely spaced points along the midsagittal plane from bregma to inion and of temporal bone anatomical landmarks. The former were resampled to yield the same number of semilandmarks on every specimen, and slid against the sample average so as to minimize thin-plate bending energy. The slid points were then converted to shape coordinates by Procrustes superimposition, which translates, rotates and standardizes each specimen to unit centroid size.

We conducted a principal components analysis on the posterior midline profile from just above lambda to inion, representing the lateral outline of the chignon, to assess how well this morphology separates modern humans from Neanderthals. Results show only a very weak separation, with modern human and Neanderthal confidence ellipses overlapping almost completely.

The morphological integration of the occipital bone midline profile with the parietal midline profile and with the temporal bone was assessed using singular warps (Bookstein et al. 2003): Three blocks of landmarks were defined a priori (occipital, parietal, temporal), then linear combinations of the original shape variables were calculated that provided the best mutual cross-prediction between the landmark-blocks. The occurrence of a highly convex and posteriorly projecting occipital profile (interpreted as the occipital bun) is highly correlated (> 0.8) with a flat parietal midline profile and with anteriorly - superiorly positioned temporal bones. While Upper Paleolithic *H. sapiens* cannot be distinguished from recent humans, most Middle-Late Pleistocene *Homo* fall outside the range of modern variation for temporal and parietal scores. However, this pattern of integration, accounting for ~30% of the total variation, is shared between modern and fossil humans.

Our results strongly suggest that the shape of the occipital profile should not be considered an independent trait, as it is so tightly integrated with braincase shape. They do not support differences in integration: both Middle-Late Pleistocene Homo, and UPE exhibit exactly the amount of bunning predicted based on extant humans given their flat parietal and the relatively anterior position of their temporal.

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Neandertal fossils in Germany –drawing a balance

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The first Neandertal fossil which has been described as "diluvial forerunner" stems from the Kleine Feldhofer Grotte, and since 1856 there have been discovered more than c. 300 fossils classified as classical Neandertals. Though the research on Neandertals started in Germany the sample of his "homeland" remained unexpectedly small and widely unattractive in comparison e.g. to France. Due to the fact that beside the name-giving skeleton all further individuals are represented either by fragmentary cranial or postcranial bones or even a single tooth, the discovery from the Neander Valley remained a more or less singular event. Because of the diminutiveness of diagnostic features of the fossils, it's no wonder that the morphological description of so-called Neandertals or Neandertal-like fossils from Germany remained debatable, doubtful or even vanished from the fossil record. Taxonomic inferences have to be based on an explicit investigation of the autapomorphic characters shown by fossils that are definitely assigned to the Neandertal clade. We expose ourselves to the dilemma of a self-fulfilling prophecy when searching for these characters in little fragments that seem to be Neandertal-like. Besides, absolute dating methods and palaeoecological research have to be optimized and always taken into account when trying to assign a fossil to a certain genus/species or time horizon.

This poster tries to draw a balance and asks for the reason why there are no more than half a dozen relevant fossils from Germany and discusses the obvious risks for wrong diagnoses.

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A 3D look at the Tabun C2 jaw

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The Tabun cave is one of the most important paleoanthropological sites in the Near East. It has yielded a long sequence of archaeological record, as well as important fossil human remains, notably the Tabun C1 partial skeleton and the Tabun C2 mandible. However, the chronology of these specimens, as well as their respective provenience, is uncertain, with most recent estimates placing the C1 skeleton at roughly 120 ka (Grün and Stringer 2000; Mercier and Valladas 2003; Grün et al. 2005). Furthermore, the affinities of the remains are debated. While general consensus sees the Tabun C1 skeleton as a lightly built Neanderthal, there is no agreement about the taxonomic placement of the Tabun C2 mandible, which has variably been attributed to early modern humans and to Neanderthals based on both metric and non-metric traits (Quam and Smith 1998; Rak 1998; Stefan and Trinkaus 1998).

We conduct a re-analysis of the three-dimensional shape of the C2 specimen using the methods of geometric morphometrics. By preserving spatial relationships among landmarks, these methods enable a better representation of shape than traditional linear and angle measurements. Additionally, they permit the quantitative assessment of traits previously described qualitatively. Finally, these methods also allow visualization of shape differences between specimens and between group means in specimen shape.

Data were collected as 3-D coordinates of twenty-six osteometric landmarks using a microscribe 3DX from Neanderthals, early modern human and Middle Pleistocene mandibular specimens. Landmarks were chosen to represent mandibular morphology as fully as possible, with an emphasis on anatomical areas that are thought to differ between Neanderthals and modern humans, including: the shape of the mandibular incisure; the position of the incisure crest on the condyle; the retromolar space; the position of the mental foramen; and the orientation of the symphysis. A previous analysis has shown these landmarks to discriminate well between Neanderthals and modern humans, and to have good classification success for recent human populations (Nicholson and Harvati in press). The data were processed using Procrustes superimposition, which translates, rotates and scales the specimens to unit centroid size. A principal components analysis was conducted, and the first few principal components were used to calculate Mahalanobis D2 distances among groups. A discriminant analysis was also conducted in order to classify the Tabun C2 specimen.

Tabun C2 falls in the area of overlap of the modern human and Neanderthal ranges in the PCA. It was classified as a modern human, but showed no affinities with either the early anatomically modern specimens Skhul 5 and Qafzeh 9 or with the Upper Paleolithic Eurasian sample. When only the fossil samples were included, Tabun C2 fell clearly with Neanderthals and was classified as Neanderthal. These results underscore the morphological ambiguity of this specimen. They tentatively support Neanderthal affinities.

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100 Jahre Neandertaler (100 years Neandertal)

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In 1956, 100 years after the initial discoveries in the Neander valley an international conference was held in Duesseldorf in order to celebrate the anniversary. The conference was chaired by Gustav Heinrich Ralph von Koenigswald. Famous anthropologists from Europe and beyond gathered and discussed the importance of the finds. This poster will recollect the events around the “Hundert Jahre Neandertaler” conference.

Neanderthal Congress 1956:
Prof. S. Sergi, Prof. G.H.R.v.Koenigswald, his nephew W. v. Koenigswald, and an unidentified participant inspecting the skulls from the Solo river.

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Vindija Cave and the modern human peopling of Europe

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Vindija cave in Croatia has yielded the youngest securely dated Neandertal skeletal remains in Central/Eastern Europe. In addition, these remains have been found in association with archaeological material exhibiting Upper Paleolithic elements. Due to its geographic location and date, the Vindija remains are particularly crucial for the understanding of initial modern human peopling of Europe and the nature of the Neandertal demise. The significance of archaeological finds and hominin fossils from this site is discussed in the light of new finds at Vindija and recent developments in the fields of paleoanthropology and prehistoric archaeology. Further, the impact of revised chronology for several crucial specimens and sites throughout Europe, and including Vindija, is discussed. We argue that the association of an early Upper Paleolithic industry and late Neandertals at Vindija is not likely to be a result of artificial mixing of specimens from different strata, but rather that these artifacts are reasonably considered to be products of the Vindija Neandertals. Although similar archaeological samples in Europe have traditionally been regarded as Aurignacian and automatically assigned to anatomically modern humans, we believe many of earliest Upper Paleolithic assemblages are in fact derived from local Mousterian, and the question of which population is responsible for the production of these assemblages remains unclear. The only clear association of hominin remains and the Initial Upper Paleolithic thus far has been Neandertals with the Châtelperronian. Further, Aurignacian can

Stratigraphy	MIS	Loess unit	Quota of wall area %	Quota of finds %
Late Würmian maximum 2				
MIS 2	Brabant	40	0	
Late Würmian maximum 1		Hesbaye	5	50
Middle Würmian	MIS 3	Ahrgau	0,01	0
Early Würmian maximum	MIS 4	Keldach	27	49
Rhein Interglacial Complex	MIS 5	Rheingau	1,5	0,5
Pre-Eemian	MIS 6 to ?11	Pre-Eemian loess	25	0,5

Tab.1: Shares of the loess units in the Garzweiler open-cast mine and shares of Paleolithic finds

no longer be considered a single Pan-European industrial complex, but rather represents a number of local early Upper Paleolithic industries. In this light the association of Neandertals and Early Upper Paleolithic is not surprising. Unfortunately the relatively short time frame of the populational overlap between late Neandertals and early moderns, possible differential site use,and taphonomic factors, (erosion etc.) will make such *in situ* evidence unlikely to be preserved. Therefore, the Vindija G1 layer is a rare and important find. Anthropological analyses demonstrate that the late Neandertals at Vindija exhibit a more modern pattern of morphology compared to most other European Neandertals. We believe that both the anatomical and archaeological characteristics of Vindija are best explained by the Assimilation model of modern human origins.

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Relation between the mass of loess units and prehistoric find density in the Garzweiler open-cast mine

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Within the years 1998-2001 a variety of geological documentations was made in the loess cover beds of the Garzweiler open-cast mine in context of the APA project ("Archäologische Prospektion der Abbaukanten", archaeological prospection of the mine walls) (H. Kels and W. Schirmer). The recognition and subdivision of different loess units and their stratigraphical attribution was only possible by drawing of long wall sections.

Through three years two to three collectors (U. Böhner, H. Kels, T. Uthmeier) yielded numerous finds of Paleolithical artefacts and bones from the Garzweiler loess wall with its average height of 8.7 m. About 130 finds were assigned to the local loess stratigraphy.

The distribution of the finds in the Garzweiler open-cast mine was extremely surprising (Tab. 1): Only a few finds are from the Pre-Eemian loess which covers a quarter of the complete loess mass. The same applies to the Rheingau Loess (Rhein Interglacial Complex = MIS 5). Therein few finds are from its middle part, the Holz Soil. The first cold maximum of the Last Glacial (MIS 4) is represented by the Keldach Loess. Surprisingly the half of all finds was yielded here. Therein the finds are common in all horizons with a distinct concentration to its deeper part. The Ahrgau Loess only sparsely preserved was free of finds. On the other hand, the very thin preserved uppermost Hesbaye Loess representing the mature stage of the second cold maximum of the Last Glaciation yielded the other half of all finds in Garzweiler. Unlike this the Brabant Loess, deposited since the maximum of the Last Glacial, didn‘t deliver one single find.

It is conspicuous that the finds of both big find complexes, the Keldach find complex and the Hesbaye find complex, appear mainly in colluvial and soliflunctional loess layers. This points to a certain post-depositional concentration of finds. A certain reworking from older loess units may also occur. Since the material is mostely still sharp-egded and likewise bone finds do not show rounding effects only little transportation over meters or decameters is estimated. As consequence the share of reworking from older strata should be low.

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A case of blade debitage in the first phase of the Middle Palaeolithic to the site of Bapaume-les-Osiers (Pas-de-Calais, France)

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Recent research has clearly demonstrated the existence of volumetric blade reduction techniques during the Middle Palaeolithic, including the «Early Weichselian blade production in northern France», which is primarily characterized by northern sites during oxygen isotope stage 5 (110,000-80,000 BP) (Locht & Antoine, 2001). The phenomenon appears to end at the beginning of the Lower Pleniglacial (OIS 3) (Tuffreau 1983; Locht 2002). However, some slight evidence of blade production is present at the end of the Middle Pleistocene, between OIS 8 and 6. The typological aspects of this assemblage were initially studied by A. Tuffreau in 1976. Can we see in such evidence the first indications of a technical capability that would subsequently be further developed? What are the characteristics of such blade production in the early phase of the Middle Palaeolithic?

By contrast, other cores are more similar to volumetric blade core conceptions known from the Upper Palaeolithic. Deliberate preparation of cores is attested, notably by transversal removals creating a curved flaking surface and a keel. The use of crests is confirmed by the presence of two crested blades. These cores were subject to bipolar and rotating reduction. Blades are fairly common in the assemblage and vary in size. Platforms are primarily facetted, wide and thick, suggesting the use of a stone percussor. Finally, bladelet production is attested by the presence of a single core and four bladelets.

The lithic assemblage from this site thus demonstrates that blade production was managed according to structured volumetric conceptions since the early phase of the Middle Palaeolithic (OIS 7) and identical to that observed during OIS 5. There is no evidence for a „proto“ phase of blade production. In addition, this assemblage is far from being an isolated case during this period, since we also find highly structured blade production in the contemporaneous sites of Le Rissori in Belgium (Révillion 1995) and the recently discovered site of Therdonne in Oise (OIS 7, Locht et al. 2000). Were such examples of blade production anecdotal during the initial phase of the Middle Palaeolithic?

It is plausible that future research will reveal new evidence of blade production during the Saalian period of the early Middle Palaeolithic. Moreover, like the study of the Bapaume assemblage, re-analysis of other sites may reveal previously obscured evidence of blade production. In effect, recognition of non-Levallois blade industries presenting a volumetric structuring comparable to that seen in the Upper Palaeolithic is recent. Once alerted, it is probable that researchers will identify more examples, extending in age such production, which was until now rather the privilege of the more recent phases of the Middle Palaeolithic, mainly situated at the beginning of the Early Weichselian (OIS 5). As a result, the chronological position of this phenomenon would be less well defined, since it is present from OIS 7 to the beginning of OIS 4.

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Sphenoid Bone in the Human Lineage

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The sphenoid is the central bone of the human skull. Forming the skull base bone complex with the ethmoid and the basi-occipital part, this sphenoid bone is associated with the skull vault bones, the face complex and indirectly with the vertebral column.

Our method is based on the use of radiographs for 107 *Homo sapiens*, 27 *Pan* and *Gorilla*, in addition with 23 fossil hominids, as *Paranthropus*, *Australopithecus*, *Homo erectus* and *Homo neanderthalensis*. Classical measures as length and angulations are completed by a new model for the inner profile of the endocranium, witch is called the “ellipses method”. It’s using coronal, transverse and sagittal radiographs of the skull.

The statistical analyse that follows gives us a new point of view upon the classical skull base flexion. This flexion is a well known characteristic of Human lineage. In *Homo sapiens* the skull base is extremely bent in an occipital bascule movement.

Compared with the African Apes, and using the Principal Component Analyses, this flexion could be split into five major processes. The main is the **spheno-occipital flexion**. This is linked with a **pharyngeal flexion**, accompanied by an enlargement of the **sphenoidal facial area** and a **dorsal expansion**. The vault is seen in hydrostatic balance with the Sphenoid by the way of the “**ellipses method**”.

Then we can see that the vertical gain is given by the Sphenoid bone to the entire skull base, thus to the postural disposition of the axial skeleton. Four main rotation modes can be separated for distinction in the sphenoidal rotation during our evolution since early stages. It could be useful to discover a recognized fossil ape to complete this approach.

However Neanderthal are distinguishable by their specific basioccipital conformation, that is at the same time a little longer and less flexed, whereas the pre-sphenoid bone is very high. Hence a stretching base regarding general *Homo* evolutionary trends which we observed here. Neanderthal and European pre-neanderthal group shows here a fifth rotation mode as a specific feature.

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Climatic changes and micromammal assemblage modifications in the Italian Peninsula during the six last MIS

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Mammal faunas were changing in composition throughout Pleistocene. During late Middle Pleistocene and Late Pleistocene alternative “cool”/“cold” and “warm” mammalian assemblages characterizes the fossil associations of mainland Italy. The presence of the wooly mammoth and the wooly rhino in the southernmost part of Apulia (SE Italy) are a classical and very well known example of climatic deterioration during

Late Pleistocene. In the last thirty years small mammals have been used as indicators of climatic fluctuations. Modifications in the communities of small mammals are strongly influenced by climate changes and the abundance of their remains in many sites (in karst fissures and caves but also in lacustrine and eolic sediments) allow to use statistical methods for the study of modifications of the fossil assemblages, and therefore, to obtain a quantitative approach. The study of the composition of micromammal assemblages of Italy since MIS 6 (Marine Isotope Stage) pointed out the following modifications: a) the assemblages of NE Italy just older of MIS 5e (Tyrrhenian auct.) were characterized by the presence of alpine or "boreal" elements like *Marmota marmota*, *Microtus oeconomus*, *Myotis dasycneme*; by some species lacking today from Italy like *Cricetus cricetus* and *Dinaromys bogdanovi* and by the extinct species *Pliomys lenki*. In Southern Italy were still present the extinct species *Allocricetus bursae* and *Iberomys brecciensis*. *Microtus (Microtus)* spp. were present in the North as well in the South but with low percentages in the latter; b) during the last interglacial (MIS 5) in Central and Southern Italy *Terricola savii* and *Crocidura* were the dominant taxa. *Microtus (Microtus)* was a common element in the North; c) at the beginning of MIS 4 (beginning of the Würm glaciation) several "boreal" species were present again in NE Italy (*Sicista betulina*, *Microtus gregalis*, *M. oeconomus*, *Ochotona pusilla*, *M. dasycneme*) characterizing assemblages corresponding to different environments. *Cricetus* and *Marmota* spreaded in Central Italy. The assemblages of small mammals were dominated by *Microtus arvalis* (in Southern Italy too); d) during MIS 3 *M. arvalis* was always the dominant taxon despite of the increase of *T. savii* in the assemblages of Southern Italy; e) for MIS 2 the data set is very abundant. Several "boreal" elements were present in NE Italy. *M. arvalis* and *Microtus agrestis* were the commonest species in the small mammal assemblages of that time. The first species was very common also in the assemblages of Central and Southern Italy whilst the second one was present in the Apulian faunas but almost absent from the assemblages collected in the Western side of the Italian peninsula. The differences between the two sides of the peninsula are not limited only to this taxon: different percentages of presence of several taxa and colonization of the Adriatic side to its southernmost part by a few species not present in the southern part of the Tyrrhenian coast have been observed.

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The lithic production systems of the Middle Palaeolithic settlement of Le Fond des Blanchards at Gron (Yonne - France)

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The Middle Paleolithic settlement of le Fond des Blanchards was discovered in 1996 in a gravel quarry of the Yonne valley (Paris Basin, France). It was included in an alluvial sequence, the Gron formation, which overlies the 3 ± m incision floor. The settlement has yielded several prehistoric levels attributed to the Lower or Middle Pleniglacial substages. The lower levels are interstratified in a sandy bank deposit belonging to a braided channel. A loamy sand representing floodplain deposits contains the upper levels. The D levels are resulting from different occupations in the same natural context, along the river bank. Faunal remains found on the settlement (reindeer, horse and bison) testify to a cool climatic condition and an open landscape. The lithic artefacts configuration shows that all stages of the flakes production in the chaîne opératoire are represented in situ, from the acquisition of raw material to the blanks transformation in tools. The flaking modalities are varied and lead to the production of a large diversity in the flakes morphology, « typo-tools » are rare. At the C level the stone production is resulting from a simple flaking modality where the large flakes obtained are transformed into scrapers. Found in great number, they are structured along the same manufacturing conception: it involves intensive recrafting. The techno-functional analysis, allowed to reconstitute the transformation modalities, and showed the production of various types of blanks where recrafting takes place in specific ways to the different techno-types. The lithic assemblages of le Fond-des-Blanchard have been qualified, on techno-typological criteria, as « Moustérien de type Quina », as it was described in the South West of France. But the last technological and techno-functional analysis allows us to reconsider this attribution. The lithic production systems of le Fond-des-Blanchards are both, classical Quina-like and as original as Levallois. The production objectives seem to be more varied and the manufacturing of tools leads to the realisation of different morpho-types of quite functionaly precise scrapers. The lithics production systems of le Fond-des-Blanchards, beyond the typological and technological differences, lead to revise our definitions, and to look anew at the variability of the neanderthalian lithic industries.

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The Franche-Comté (France). Crossroads of eastern and western influences. Studies of the technical system of Mousterian societies at the dawn of the early upper Paleolithic

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The Franche-Comté may be considered to be one of the large regions of France which has been neglected by French mousterian archaeology. Several points confirm this inescapable fact. The first, from a quantitative point of view, which reflects the lack of enthusiasm for research, is the well-known insufficiency of currently available documentation. The second, which is of qualitative nature, concerns the intrinsic value of collections and prehistoric sites. Few of them indeed present satisfactory conditions of study.

Nevertheless, in spite of this situation, the interrelated study of a number of sites permits us to indicate an undeniable interest presented by the technical and cultural traditions of the Mousterian *franc-comtois*. These sites are 'la Baume de Gigny' (Gigny-sur-Suran, Jura) and most particularly the level VIII, le Trou de la Mère Clochette (Rochefort-sur-Nenon, Jura), la grotte de La Piquette (Rurey, Doubs), and finally surface sites of the Oligocene Bassin de Mont-les-étrelles (Haute-Saône).

It is necessary to comprehend the current situation as a vast puzzle in which sites and cultural traditions are interconnected. (fig. 1).

Four main lines underlie our reasoning :

- the development of a bladeflakes debitage associated to baked blades.
- a particular discoïd debitage, developed on a specific raw material,
- the presence of tools of eastern origin,
- the undiputable presence of points of Châtelperron.

The first two lines hinge on the technical convergence which has been observed, isolated and defined. First between the level VIII of la **Baume de Gigny** and **La Mère Clochette**, a classical variability of the discoid debitage, a bladeflake debitage and a marked utilisation of baked knifes coexist simultaneously. Furthermore,we have observed the unity in techniques applied to a

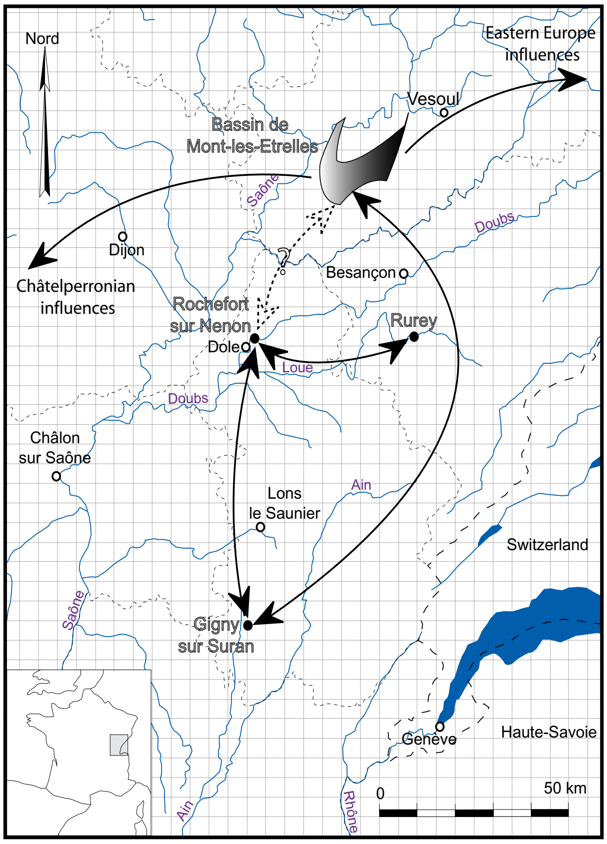

Figure 1. Location of the Bassin oligocène de Mont-les-Etrelles and of the main sites mentionned in the study.

specific raw material, at once characteristic of the site of **La Piquette** and of **La Mère Clochette**.

The third line regroups two sites which present evidence of eastern traditions in tool-making. For example, two prondnicks are present in the level VIII of la **Baume de Gigny** (relative date : 35 000 BP), and one szeletian point or Blattspitzen have been found in a surface site of **Mont-les-étrelles**. G. Bosinski has 'authenticated' the latter by means of photography. This piece is presently the most western expression of Eastern and Central European industries in France (Bosinski, 1964 ; Oliva, 1990 ; Valoch, 1990).

Finally, three points of Châtelperron have been found in this vast place area of the **Bassin de Mont-les-étrelles**. This last main line develops in relation to the most eastern expressions of the Châtelperronien. We associate this discovery with the very controversial Châtelperronian of **La Mère Clochette** (Desbrosse, 1984 ; Fabre et Lopinet, 2006). Although "« *il paraît peu contestable que l'on se trouve, dans ce secteur du Jura et de la Saône, hors délimitation frontalière du Châtelperronien au sens strict »* (J. Combier, 1990 : 270), however it is very interesting to go beyond this remark in tracking down the expressions of this culture.It needs to be said that, in the east of France, the Châtelperronian deficiency is due more to a scientific reality than to an archaeological reality.

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Space-time approach of a Middle East mousterian territory from the technological study of lithic industries of the complex VI3 of Umm el Tlel (Central Syria)

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The site of Umm el Tlel, in the El Kowm basin in the middle of the Syrian desert, has an extremely rich stratigraphy, in particular for the period of the Middle Paleolithic. The abundance and the quality of this recording make it possible to approach some dynamics of occupation with an often unhoped-for sharpness for the sites of this period. The approach to these dynamics can follow both a synchronical and diachronical axis. On this subject, the archaeological levels included in the geological complex VI3 offer an incomparable example. This complex corresponds to a lake phase during which the site was regularly covered by water and sediments. When the water level dropped, the site was systematically occupied by men. Nine archaeological levels follow one another within this complex dating back to approximately 75000 years.

According to a synchronical axis, the dynamics of space occupation can be particularly defined thanks to a fine lithic study of the material discovered on the site. Here, we take the example of the material excavated in the VI3a' layer. This industry is predominantly produced from tertiary flint, occasionally from cretaceous flint. This raw material, naturally completely absent of the site, was collected as well in primary position as secondary at a few kilometers of the site. The technological study revealed the coexistence of at least two chaînes opératoires of flaking:

- One or more chaîne opératoire Levallois récurrente on blocks lower than 7/8 cm, centered on a production of points associated with quadrangular and débordants flakes. The whole of the products stemming from this chaîne opératoire seems present on the site, but a difference between the methods of initialization observed on cores and the flakes obtained lets foresee the possibility of a permanent circulation of the stone artefacts between several sites occupied by the human group.
- A chaîne opératoire Levallois récurrente on larger blocks, which was aimed at producting points and laminar and quadrangular flakes. For this chaîne opératoire, only these blanks were found. They were thus probably imported after their realization.

Other data, like those concerning the remains of hunted fauna collected in this level, complete these results. They also take part in our best comprehension of the status of the site at that time and, in a more general way, in its place in a territory which one can consequently allow to outline.

A second dimension of this dynamics of occupation, diachronic this time, can be approached by the study of the whole of archaeological layers of VI3. According to analyses carried out until now, these layers are characterised by an amazing homogeneity throughout this particular geological context, and this from any point of view (concept of stone flaking, acquisition and treatment of fauna, function of the site...). Thus, in spite of this good characterization of the behaviors of the men who produced the vestiges discovered in the VI3a' layer, witnesses of a strong cultural value, these behaviors remain on a long duration (not easily calculable), even after regular abandonments of the site.

Consequently, it is possible to foresee a rigidity of the Mousterian territories in which, in spite of intermittent occupations, one turns over regularly in the same points, perhaps even after an abandonment during several generations, to make the same activities exactly there. Thanks to this favorable sedimentary context which makes it possible to distinguish from the discrete archaeological events, one can perceive at the same time the complexity and the stability with which the men of the Middle Paleolithic conceived the space they occupied.

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Non-knapping methods of flint tools shaping

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Some bifacial flint tools of Middle Palaeolithic age, as like these coming from Wylotne Shelter (South Poland), show the features which cannot be explained on a ground of knapping technology as we understand it today. Analysing a bigger sample of such specimens leads to a conclusion, that occurrence of mentioned features is not a result of coincidence. The poster presents the results of an experiment intended to reconstruct the technology involved in creating such tools. However the results are preliminary and have to be confirmed, they seem to be helpful in understanding the complexity of Neanderthal behaviour and technology.

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Technological behaviour and mobility of human groups through lithic assemblages at the end of Middle Pleistocene and beginning of Upper Pleistocene: the middle Rhône Valley (France)

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The « Middle Rhône valley » in south-eastern France is a vast corridor bordered by low plateaus and valleys. This area has yielded about 12 sites with one or several human occupation levels, dated to the end of the Middle Pleistocene or the beginning of the Upper Pleistocene (OIS 9 to 3). Most of the human occupation levels are dated from OIS 4 and the beginning of OIS 3. The oldest sites are rare, Orgnac 3 (OIS 9-8), Payre (OIS 7-5), Abri Moula (OIS 6-4), Abri des Pêcheurs (OIS 5-3). The few human remains belong to the Neanderthals (Orgnac 3, Payre, Abri Moula, Abri des Pêcheurs, Baume Néron). New geological, stratigraphical, radiometric, palynological and faunal studies on these sites give patterns for a first chronological and environmental framework for the human occupation in this area.

Inside this new framework, the analysis of the lithic assemblages has been carried out to observe how humans inhabited this area over time, through raw material gathering and technological and subsistence behaviour. The analysis of human needs shown in each occupation (kinds of artefacts, tools), and consequently the processing systems used, guides the studies.

Results show that the raw material collecting is above all local and semi-local (less than 20 km), in an area rich in flint (Jurassic and Cretaceous formations on the right bank of the Rhône river). New studies on the site of Payre, dated from the OIS 7 and 5, give evidence of a gathering of some stones carried from a long distance from the south (60 km?). This cave has shown evidence of seasonal occupations for hunting one or several mammals, as for majority of the human occupations of this area. Flint is the main stone employed (with rare exceptions), associated with local stones such as quartz, quartzite, limestone and basalt. The knapping, mainly inside the site, took place first on flint, rarely on quartz or other stones. The other kinds of stones have been shaped (pebble tools). The core reductions belong to the discoid, Levallois or laminar methods, according to the sites. In some sites, two or three methods have been used together, especially when the laminar method is used. The tool kit is rather poor, composed by side-scrapers and points. The retouch does not change the shape of the product, except for some rare Quina sites.

Most of the sites show a continuity of the technological or subsistence behaviour over time, explained perhaps by the function of the settlement or the sedimentation record. The lithic variability among sites cannot be linked with chronological data, except for the laminar processing system which is related to the beginning of the OIS 4 as in all southern Europe. Various activities and traditions certainly explain this diversity which cannot be put in parallel with the subsistence

patterns. The whole data provide the idea of a large mobility of human groups, travelling on small territories for daily subsistence. Humans moved on plateaus and valleys, along the Rhône corridor. No evidence of travelling through western areas in the Massif Central mountain can be attested today through raw material collecting, while any geographical obstacle stops human movements in all the south-eastern Massif Central borders.

The conclusions support the hypothesis of the existence of mobile groups, using above all the local raw materials and game, during seasonal stops. The originality of this area can be observed in relation to other geographical settings, like the large North European plain or south-western France.

MONCEL M-H. (2003) « L'exploitation de l'espace et la mobilité des groupes humains au travers des assemblages lithiques à la fin du Pléistocène moyen et au début du Pléistocène supérieur. La moyenne vallée du Rhône entre Drôme et Ardèche », BAR Series Internationales, S1184, 179 p.

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Homo heidelbergensis Schoetensack, 1908: new insights. A morphological study of Pleistocene mandibles

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With the discovery of new important fossil specimens in Africa, Asia and Europe and the reconnaissance of a greater diversity in the middle Pleistocene fossil record (1),the species Homo heidelbergensis (2) named from a jaw found in Mauer in Germany has been reused in order to define the plylogenetical status of numerous fossils. However, there is currently no consensus on the classification of those fossils. Some authors propose that Homo heidelbergensis is an Afro-European taxon that preludes the apparition of both modern humans and Neandertals (3, 4); whereas other workers think that it is a European species which is part of the Neandertal lineage (5). In this study we intend to focus on the morphological features of the Mauer mandible. We want to discuss its validity as a taxon and infer possible evolutionary theories, using the base of species recognition- anatomical description. Two methods were used in this work. The first stage is a morphological study that was performed on 36 fossils mandibles from Africa, Asia and Europe and 35 historical specimens. The fossil sample ranges from the beginning of Pleistocene to Holocene. 50 mandibular traits were observed and coded in order to understand their individual relative importance. Statistical analyses were then run on the data base and allowed us to estimate distances between specimens (Pearson's Phi tetrachoric correlation). We obtained a matrix of similarities which was then analysed thanks to hierarchical classifications (dendograms) of the fossils, and non-metric multidimensional scaling. The results of this study shed light on some characteristics that support Homo heidelbergensis as a valid taxon. Based on the Phylogenetical Species Concept (Cracraft, 1983) the appearance of three new traits can be used to define Schoetensack species (position of the lateral prominence under M3, truncated gonion profile and horizontal retromolar surface). Moreover, those traits are present on specimens (i.e. Tighenif, Sima de los Huesos) that show close relationship with the Mauer mandible. Thus it seems possible to consider Homo heidelbergensis as a valid species. However, it is still difficult to decide whether the Rightmire's or the Bermúdez de Castro's theory is the most reliable. Indeed, hierarchical classifications show significant association between both African and European specimens with the Mauer fossil. Therefore, this study allowed us to improve the definition of Homo heidelbergensis. Nevertheless, more researches are needed in order to clarify evolutionary relationships that exist between middle Pleistocene fossils. We propose to enlarge the sample and the anatomical areas studied to better comprehend the situation. The use of cladistic as well as metrics methods will also help us in this aim.

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Is the occipital bunning one of the evidences for continuity between Neanderthals and early modern Europeans?

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The occipital bun is one of the most interesting Neanderthal traits. This characteristic is described variably as a posterior projection of the occipital squama, or a great convexity of the occipital plane, and is associated with lambdoidal flattening. The occipital bun is usually considered a derived Neanderthal feature, but not a Neanderthal autapomorphy. The presence of this trait, or "hemibun" in Late Paleolithic Europeans specimens has been seen by some as evidence of continuity or interbreeding between Neanderthals and early modern humans in Europe. If this trait is an evidence of regional continuity, then buns in Neanderthals should be homologous with posteriorly - directed projections of the occipital beyond the nuchal plane evident in some early modern humans from Europe. The presence of the bun in some modern *Homo sapiens* from geographically diverse populations might suggest that this trait is not an evidence for regional continuity between Neanderthals and subsequent Upper Paleolithic populations in Central Europe. This study examines presence and degree of similarity of this feature between modern humans and Neanderthals. Three metrical features were collected along the midline (lambda – inion) and were used to calculate two traits: 1) the angle which describes degree of convexity of the occipital squama; 2) the ratio which describes location of the most convex part of this squama. These two traits were used to quantitatively evaluate the shape variation of the posterior cranial profile in 6 Neanderthals, who have been described in literature as possesing a bun. The fossil human sample, which included specimens without bun (*H. erectus sensu lato* – 6, *H. heidelbergensis* – 2) was used as a control sample. The posterior cranial profile morphology in fossil and recent modern *Homo sapiens* was analyzed. The analyzed sample included: 11 Late Paleolithic Europeans, 6 early anatomically modern humans from Africa, 37 recent *H. sapiens* from Africa and 37 from Australia. The results indicate presence of the bun in 2 Late Paleolithic Europeans, 1 early anatomically modern human from Africa and 11 recent modern humans from Africa. The "hemibuns" were present in 8 Late Paleolithic Europeans. The amount of external projection of the *planum occipitale* in 24 recent *H. sapiens* (20 from Africa, 4 from Australia) was the same as in Neanderthals. The results show that bun probably isn't an evidence for regional continuity between Neanderthals and subsequent Upper Paleolithic populations in Central Europe. Trinkaus and LeMay (1982), Lieberman (1995), and Lieberman et al. (2000) have suggested that among modern humans the bun may be a developmental consequence of having a large brain on a relatively narrow cranial base. This trait has been described by them as an example of convergent feature not homologous between Neanderthals and some early modern humans. In this study, the morphological similarities concerning some metrical traits of the cranial shape were statistically analyzed between several hominins groups. The First of the analyzed groups of recent modern humans (from Africa and Australia) encompassed crania with the bun (11 specimens) and without it (63 specimens). The second included crania of recent modern humans from Africa and Australia with Neanderthal's angle of convexity of occipital squama (24) and crania without this feature (50). The third contained – Neanderthals' crania (6), Late Paleolithic Europeans' crania with bun and "hemibun" (10) and recent modern humans' crania with bun (11). The result supports the hypothesis that bun is an example of convergence, and shows that height of the cranium can probably be one of the features important for model of developmental basis of the occipital bun.

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Enamel Volume and Thickness in Neanderthal Molars: a Microtomographic Investigation

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Previous investigations of molar enamel thickness have concluded that Neanderthals have thinner molar enamel than recent fossil Homo sapiens as well as modern humans. This difference has been used to support a specific distinction for Neanderthals, as well as inferences about life history and general health. However, previous studies were based on lateral flat-plane x-ray radiographs, which are inadequate for measuring enamel thickness. Uniquely thin molar enamel in Neanderthals has yet to be confirmed using accurate imaging techniques, despite the purported relevance of this anatomical character to studies of the health, development, and taxonomic affiliation of fossil specimens.

Microtomographic (mCT) imaging techniques have been demonstrated to accurately portray internal dental structures, thereby facilitating measurements of enamel thickness and volume. In the present study, 45 Neanderthal molars from six sites were subjected to mCT scanning (synchrotron mCT and laboratory mCT) in order to calculate dental tissue volumes and surface areas. Volume models of each tooth were also used to create mesial planes of section in which two-dimensional (2D) enamel thickness metrics were recorded. High incidence of occlusal wear limited the size of the sample; only unworn/lightly worn teeth were used for tissue volumes and 2D thickness analyses.

Results of volumetric analyses reveal that Neanderthals have a slightly lower volume of molar enamel than published analogous measurements of modern humans, and a slightly larger enamel-dentine junction (EDJ) surface area; the average enamel thickness (enamel volume divided by EDJ length) of Neanderthals is thus less than in modern humans. Coronal dentine volume, however, is substantially greater in the Neanderthal sample than in modern humans. Thus, when average enamel thickness is scaled by dentine volume (per commonly used methods of controlling for tooth size in inter-species comparisons), the relative volume of Neanderthal molar enamel is far less than in modern humans.

Results on 2D mesial planes of section mimic those of the volumetric study; two-dimensional average enamel thickness is slightly less in Neanderthals, and relative enamel thickness (scaled by dentine area) is substantially less in Neanderthals. The well-documented trend of increasing average enamel thickness in modern human posterior molars is apparent in Neanderthals as well, as the third molar has the thickest enamel compared to the first and second molars.

Neanderthals thus appear to be characterized by relatively thinner enamel than modern humans, as previously suggested. When the individual components of enamel thickness indexes are examined, however, it is clear that Neanderthal molar enamel is only slightly thinner in terms of absolute thickness and volume. The scaling factor employed in inter-species comparisons (dentine volume or area), however, is much larger, causing relative enamel thickness to be less than in modern humans. Finally, while some scholars attribute thin enamel in Neanderthals to an accelerated life-history trajectory or an indication of relatively poor health, evidence from other hominoid primates suggests that neither of these is necessarily true.

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Revisiting neandertal genetic diversity with the 100,000 year old specimen from Scladina (Belgium)

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The long coexistence of the Neandertals and premodern Humans in Europe has raised questions about whether their populations remained reproductively isolated or experienced some level of admixture. Last years, molecular biology has taken advantage of traces of mtDNA sequences still conserved in fossilized bones to track the genetic legacy of Neandertals among modern Europeans. Such a genetic continuity would have been the hallmark of interbreeding between modern humans and Neandertals at the time of their European coexistence. However, the mtDNA sequences from the nine neandertal specimens that have been analyzed to date - and that lived around the time of the cohabitation period - do not match those found among modern humans, suggesting low interbreeding, if any. We retrieved 123bp of the mtDNA HVR-I from a 100 KY-old Neandertal tooth from Scladina (Belgium). Phylogenetic analysis clusters all Neandertal mtDNA apart from the mtDNA of contemporary modern humans. Moreover, since it unambiguously predates the period when Neandertals cohabited with modern humans, the Scladina sequence allows to check for any modification in the neandertal mtDNA-pool around the time of cohabitation by comparison with the already published - and considerably younger - neandertal sequences. The results concerning the genetic diversity of Neandertal populations will be presented in the light of the Scladina sequence.

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What before the Aurignacians? A discussion on land use, subsistence and technology of the last Neanderthals in the Italian Alps

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Italian Alps were a familiar region for the last Neanderthals. Evidence from several sheltered and open-air sites prove that these humans provisioned and exploited the mineral and animal resources in the same way modern humans did, and that this organization of economic activities was deeply rooted in the social systems from earlier times in the stage 3. Human occupation spans from lowland to highland in the fringe between the Alps and the Po – venetian plain, a belt where the geographic and ecological contexts differ at a very small-scale. Chronometric, palaecologic, economic and cultural evidence reveal how humans adapted to the climatic shifts, used different sites for different targets and, above all, improved advancements and variability in lithic technology at the very end of their period.

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3D numerical model, scanning survey and video record of Altamura Man bones in their cave site

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From the moment of the discovery of the Altamura Man various elements rendered the find singularly spectacular, for what regards its integrity and completeness, its position in the karstic cave and for evolutionary meaning of the anatomical and anthropological characters of the remains, attributed to an archaic phase of the Neanderthal cycle. The selected approach was based on possibility of observing the remains in situ, allowing specialists from different disciplines to plan successive work stages while respecting strict monitoring controls to protect the site and remains while still allowing general cultural-touristic access. The solution proposed and realized (Pesce Delfino et al., 2001; AAVV, 2002) was based on the idea of remote observation: a “from-the field museum” in which visitors are not allowed to visit the site, thus guaranteeing the highest levels of conservation and protection. Observations and surveys were conducted to define certain aspects regarding the collocation of the human remains and their morphology. The general survey of the cave and the three-dimensional topographic distribution of the human bone segments were also obtained by using laser-scanning technique. Presently results of in situ laser scanning of single bones, including skull, tridimensional anaglific videomovie and building up of derived 3D numerical models are reported.

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“When passing through” - About circulation forms of lithic products during the Middle Paleolithic

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If the transport of lithic products “from” (inputs) and “to” (outputs) is frequently noticed in archaeology, the identification of products passing “through” a site (transit products) presents more difficulties. Such observations require notably fine investigations which application seems more relevant in low artifact density contexts. We propose here to present a work conducted on two short-term occupation sites (Pié Lombard rockshelter, France and Broion cave, Italy) which present also the interest of having been entirely excavated. The study of these two lithic assemblages, after methodological evaluation and precisions, gives the possibility to observe “phantom” products, tools but also cores. At last, the study permits us to discuss about technological provisioning strategies during Middle Paleolithic and underlines the necessity to generalize such observations.

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The last Neanderthals of Cantabrian Spain

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The Cantabrian region of Spain presents a quite interesting opportunity for investigating the settlement patterns of Late Mousterian and its relation with the Early Upper Paleolithic. Similarities between these periods are present not only in the lithic technologies and subsistence management but also with the presence of symbolic elements found among the artefacts uncovered from the cave sites, particularly from El Castillo, but also from Cueva Morín or Lezetxiki or El Esquilleu, among others. All this could be integrated into a scenario that permits us to propose a complex system of landscape use, which comprises the use of very different ecozones ranging from the coastal plain to the mountains. The scarce evidence of Neanderthals brings us to propose a late, but innovative, presence of this group in the area.

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Healed fractures : The Krapina Neanderthal

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The Krapina Neanderthals exhibit healed fractures of an ulna, a clavicula and a skull. X-ray analysis documents a number of specimens with alterations that are the outcome injuries caused by trauma from accidents or from fighting. Our observation leads us to conclude in this study that the Krapina Neanderthals were able to successfully treat fractures during their life periods. There are also indications that Krapina Neanderthals were able to provide care for wounded and ill members in their community.

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A new Thermoluminescence technique for dating small heated flint artefacts

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Thermoluminescence (TL) dating of heated flint is frequently used to establish the age of Neanderthal sites and other Palaeolithic occupations. It is a dosimetric dating method, which employs the accumulation of radiation damage in crystal lattices. A piece of flint (as well as chert, hornstone, quartzite, etc.) can be dated by TL methods if it has been heated in a prehistoric fire to about 400°C. In principle, the method is applicable to almost one million years and has, in most cases, the advantage of an archaeological event to be dated directly. An overview of the techniques, parameters involved and a discussion can be found e.g. in Richter (in press).

Because of the irregular shape of most artefacts, it is difficult to establish the radiation dose contribution from alpha and beta emitters contained in the surrounding sediment. Therefore the outer two mm surface of each sample is removed in order to achieve a more precise result. Any parts which might have been affected by daylight during excavation are thus removed as well. Given such a removal and the need for about one to two grams of extracted material for standard TL dating, the samples for dating have to be relatively large in the order of 10-15 g.

A new TL-technique has been developed (Richter & Krbetschek), which employs the orange-red TL emission and a single aliquot regeneration (SAR) protocol. In principle, an age estimation with only a few mg of material after surface removal is thus possible, which reduces the size of samples considerably. The only remaining restriction therefore is a minimum thickness of 5-6 mm and only a few grams of weight. Therefore many more Palaeolithic sites (e.g. Gesher Benot Ya‘aqov, Israel) which contain only small pieces of burnt flint can now be dated.

Extensive methodological test were carried out, as well as comparisons of the technique with different ‚traditional‘ TL-dating techniques (Richter & Krbetschek ; Richter & Temming). Heated flint samples from the Middle and Early Upper Palaeolithic sites of Bau de l‘Aubesier and Bérigoule in France, Jerf al‘Ajla in Syria and the Geißenklösterle in Germany where used for comparisons. The precision of the new technique is comparable and results are in good agreement with age estimates obtained by standard TL dating. This new technique is a new tool which allows the age estimation for sites previously considered not to be datable.

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Technological Analysis of the Bifacial Tools from La Micoque (Dordogne, France)

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The handaxes of La Micoque have made the celebrity of this site and were characteristic for the “Micoquian” described 1967 by Bosinski. Numerous discussions about this “Micoquian” have led to different understandings of it in West and Eastern Europe and to the conclusion that the phenomenon is concentrated in East and Central Europe. In the last years, the question about the pertinence of the term “Micoquian” was raised, as the Layer 6 of La Micoque, containing the handaxes, doesn’t exist anymore and the handaxes themselves had never been technologically analysed. The formal group is now defined by the presence of bifacial items, especially bifacial knives (Keilmesser), so that the name “Keilmessergruppen” (bifacial knives groups) has been proposed. This contribution presents the results of the techno-functional analyses of the handaxes of La Micoque (Rosendahl 2005).

In order to clear the concepts underlying the production of the bifacial tools of La Micoque, an analysis of the techno-functional units (Boëda 2001), short TFU, was undertaken. This consists in identifying the conceptual zones defining the volumetric organization of the piece from the beginning of its fabrication. Each TFU is normally present on both sides of the piece, i.e. it defines the volumetric organization of the faces and the character of the edge. Three kinds of TFU can be identified: active (working), passive (handle) and alternatively active and passive. The position of the TFU within the piece and their role (active, passive or both) allow recognizing the overall concept underlying the fabrication of the piece from the beginning as well as eventual modifications during the use.

Two concepts are present in La Micoque. The first one leads to the production of handaxes *sensu stricto* with a roughly symmetrical organization along the length axis. Two active TFU with similar characteristics form the point and the top of the piece. They can cover the total length of the long sides up to the basis. The basis carries usually, but not obligatory, a passive TFU. Additive TFU can be placed between the top and the basis. They are usually organized symmetrically and can be active or passive. A piece with “handaxe concept” can therefore be hold and used on several ways and all TFU can be at least potentially active.

The second concept produces bifacial knives, characterized by the asymmetrical organization of their TFUs along the length axis. The main active TFU is localized on one of the long edges, opposed to a back that is always passive on the other edge. A further active TFU can be situated at the top of this edge and form a point with the main TFU. The basis is usually active. A piece with “bifacial knife concept” can therefore be hold on maximum two ways and always has an absolutely passive TFU.

The pieces of La Micoque have only been sharpened; they don’t show marks of intensive reworking or modification of volume. The concept chosen and the inner organization of the piece were therefore kept once set in place, a proof for the existence of clear concepts that were realized in the tools. The presence of a concept for bifacial knives allows us to place La Micoque in the Keilmessergruppen. However, the absence of typologically typical bifacial knives, the geographical situation of La Micoque and the unknown age of the Layer 6 let many questions open.

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The Neandertalien site Hunas: 50 ky (OIS 5b – OIS 3) climate and environment history in Southern Germany

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Hunas is located 40 km east from Nuremberg/Bavaria. The Cave ruin was discovered in 1956 and investigated up to 1964 (Heller 1983). The first excavation opened just the upper part of a long stratigraphic sequence which shows a total of 20 m sediments. In anticipation of the complete destruction of the site by the quarry new excavations have been started in 1983 and are still going on.

The cave is completely filled with bedded sediments. The roof itself has collapsed, covering the sediment-filling and sealing the cave entrance. About 12 m of sediment from the top down were investigated since 1983.

In 2002 a flowstone layer was discovered at the base of the section in the recent excavation. The layer is clearly in contact with the sediment series above without showing an obvious hiatus. A stalagmite from this layer was dated by TIMS-U/Th-method. The base yielded an age of 79 ± 8.2 ka and the top an age of 76 ± 9.6 ka (Rosendahl et al. 2006). This early Würmian age was additionally confirmed by dating a second stalagmite from the same layer. These new dates indicate a maximum age of around 88 ka for the base of the section. The minimum age of the site is constrained by the presence of typical Middle Paleolithic artifacts within the top layer of the section. Therefore the whole sediment stack was deposited within a maximum time span of around 50 ka (OIS 5b till OIS 3; Rosendahl et al. 2006). First rock magnetic analyses (magnetic susceptibility stratigraphy) indicate also an Upper Pleistocene age.

About 140 different taxa (mammals, birds, reptiles, amphibians and molluscs) were found in Hunas. The most important paleontological finds belong to primates. Five remains of *Macaca sylvanus pliocena* were found. According to the new datations these finds represent the most recent occurance of *Macaca* in the Pleistocene of Central Europe. New anthropological analyses of a single human tooth found in 1986 support its assignment to the genus *Homo neanderthalensis* (Alt et al. 2006). Middle Paleolithic Artifacts were discovered in nearly all layers.

Due to the distribution of each species, multiple changes of climate are reflected in the stratigraphy of Hunas. Beginning, from bottom to top, with a phase showing temperate to warm climate and vegetation in the layers P-L with *Muscardinus avellanarius*, *Apodemus maastrichtiensis*, *Clethrionomys glareolus*, *Pitymys subterraneus* and other woodland-forms. The absence of these forms in the following layer (K_{down}) indicates a climatic deterioration, but their re-appearance in the next layers (K_{middle} - H) verify again favourable humid and warm conditions. Here most of the remains of *Macaca* were found. In the layers G2 and G1 - G3 is represented very poorly in the excavation since 1983 - a clear and rapid change to colder and dryer conditions turn up, illustrated by *Lemmus lemmus*, *Dicrostonyx gulielmi*, *Microtus gregalis* or *Microtus oeconomus*. G1 with coarse, sharp-boardered rock debris represents the coldest episode within the whole stratigraphy. The covering layers F – D show an improvement of the climate. All taken together, the complete sequence reflects a gradual development from an ending warm phase to a significant cold climate and a final melioration.

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A new Neandertal Mandible from the northeast Iberian Peninsula (Cova del Gegant, Sitges, Barcelona, Spain)

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The Neandertal mandible we present here was recovered from the site of the Cova del Gegant, which is located near the littoral city of Sitges, south of Barcelona (Spain). While Neandertal fossils have been recovered further south along the Spanish Mediterranean coast, the Cova del Gegant is the only known site in Catalonia documenting diagnostic human skeletal remains in association with Middle Paleolithic stone tools and faunal remains.

The cave contains Upper Pleistocene archaeological and paleontological material, and forms part of the Garraf Massif, a low-relief mountain chain and karst system in the Serralada Litoral of Catalonia. Cova del Gegant is currently accessible both by sea and from above through a 20 meter natural vertical conduit. The principal chamber branches off on the right side into two lateral galleries, one of which is next to the sea and the other is interior. At the end of the principal chamber there is a small conduit, which joins the Cova del Gegant with another parallel cave (Cova Larga).

The mandible was recovered during the first excavation season in the cave, by Santiago Casanova and some excursion members (Amunt) from Sitges in the 1952. Pleistocene faunal remains were also recovered from the lateral gallery near the sea, but this collection was not studied until 2001, when the archaeological material was in a public institution (Arxiu Historic de Sitges). Subsequent interventions in the cave also yielded more faunal remains and Mousterian stone tools.

The precise stratigraphic provenience of the mandible is not clear, and attempts at obtaining a radiometric date (C^{14}) were unsuccessful. Therefore the chronology of the specimen has been established on the basis of the stone tools and faunal remains recovered at the site. The vast majority of material recovered from the cave clearly dates to Pleistocene times, and only a few ceramic fragments were found in the most superficial level. The sedimentological analysis suggests some mixture of some levels by the sea action. The faunal remains from Cova del Gegant are represented in other sites with a late Middle and Upper Pleistocene chronology. Herbivores are the most abundant, and the majority of these species are adapted an open environment (*Equus caballus, Stephanorhinus hemitoechus, Bos/Bison*). In addition, carnivore remains (*Ursus sp. aff arctos, Crocuta crocuta, Lynx pardinus, Canis lupus*, *Panthera pardus)* and Mousterian stone tools were also recovered. The stratigraphy and Pleistocene archaeological remains suggest a date of between 128-40 kya, ranging from OIS 5e-3 times, with a human occupation of the Cova del Gegant spanning the first half of the Würm (approx. 100-40 kya).

The human fossil is represented by three mandibular fragments which comprise most of the mandibular corpus from the right M1 tooth socket to the mesial margin of the left M3 alveolus, although it doesn't preserve any teeth. The three fragments can be reconstructed without distortion, but the symphyseal region shows some damage anteriorly and posteriorly. Anatomically, a true bony chin is absent in this mandible, and some features associated with the derived midfacial prognathism in Neandertals are present in this specimen, particularly the posterior placement of the anatomical structures of the lateral corpus. In addition, the low position of the mental foramen, in the lower half of the mandibular corpus, seems to be a feature which occurs in a higher frequency among Neandertals and their Middle Pleistocene precursors. These anatomical characteristics suggest Neandertal affinities for this mandible.

A small bone sample was removed from the specimen for DNA analysis, and a total of 47 base pairs were sequenced from the mitochondrial D-loop. The short sequence does not deviate from the published Neandertal sequences at any of the sites where there are differences between the published Neandertal sequences and most anatomically modern humans, including an indle that appears to be diagnostic for Neandertals.

The chronology of Mousterian and Aurignacian stone tool industries (and presumably Neandertal and modern human populations) in the northeast of Spain suggests a complex pattern of human migration and settlement characterized this region of the Iberian Peninsula.

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Digitization of Belgian Neanderthals: Cultural Heritage Preservation and Scientific Exploitation

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Belgian Neanderthal are very important in the history of Paleo-anthropology. During the winter of 1829-30, Ph.-Ch. Schmerling, discovered, in the second cave of Engis, two skullcaps associated with woolly rhinoceros and mammoth bones. This find demonstrates that Man was a contemporary of large extinct prehistoric mammals. Nevertheless, he did not go as far as claiming that fossil man was morphologically slightly different from modern Humans. In 1866, the geologist Éd. Dupont discovered the "La Naulette" mandible, in the Lesse valley. The antiquity of the fossil was confirmed by a precise stratigraphic context and its association with large extinct prehistoric mammals. According to Paul Broca, this fossil constitutes: "the first event providing Darwinists with anatomical evidence. It is the first link in the chain which, according to them, extends from man to the apes". Two decades later, a more receptive scientific community willingly accepted skeletal remains of "L\'Homme de Spy", unearthed in June 1886 on the terrace of the "Betche aux Rotches" cave, 20 km west of Namur. The publication of the complete anthropological description in 1887 by J. Fraipont has to be considered as the first monograph about Neanderthals. In 1895, the femur found by F. Tihon within the caves of "Fonds-de-Forêt", in the Vesdre valley, ended up the 19th century Mosan Neanderthal discoveries. During most of the 20th century, data have been added to the known Neanderthals. These include the determination of the Neanderthal features of the Engis child (more than a century after its discovery), the comprehensive study of the "Fonds-de-Forêt" femur and new analyses of the fossils from Spy and La Naulette. The end of the 20th century and beginning of the 21st have seen renewed interest in multidisciplinary fieldwork, mainly at the "Couvin", "Scladina", "Walou" and "La Naulette" cave sites. New Neanderthal remains were unearthed making Wallonia Region one of the most abundant area of Neanderthal discoveries. New multidisciplinary studies of ancient collections like Spy or Goyet have been undertaken allowing to increase the number of Neanderthal remains. Belgian fossils (including unpublished material) have always been available for researchers. Nevertheless curators need to improve fossils preservation while promoting their scientific study which increases the risk of damage for original fossils. The TNT and MARS projects provide a technological solution and the complete Belgian Neanderthal remains collection has been digitized through the 2 programs and most of the data are now available on the NESPOS database. Skulls and long bones were scanned with the latest Medical CT equipment (Siemens SOMATOM Sensation 64 CT) producing 3D models suitable for classical and new anthropological measures. Dental material and some small bones were digitized with a Skyscan micro-scanner 1076 with a resolution of 18 µm. Surface 3D models were produced from CT files using Amira 3.1 or Artecore developed in the framework of the TNT project. The first scientific results of this digitization allowed discussing the attribution of bones between individuals of the Spy collection as well studying of specific morphometric features like the inner ear and the thickness of the cranial vault. The monograph in preparation about the Sclayn child will also include analyses based on CT and µ-CT data.

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Dental development and age at death in a Middle Paleolithic juvenile hominin from Obi-Rakhmat Grotto, Uzbekistan

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Previous work on incremental dental development in young Paleolithic hominins has been limited to studies on a juvenile Neanderthal dentition from Gibraltar and an infant Neanderthal first molar from Syria. Both of these studies were concerned primarily with determining the age at death from counts of incremental features in the enamel. Additional work has been conducted on the number and spacing of long-period growth lines in large samples of Neanderthal and Upper Paleolithic modern humans, as well as the enamel growth trajectory of a single molar from Tabun. These studies generally suggest that Neanderthals experienced a shorter period of dental development than modern humans and/or Upper Paleolithic hominins, although Neanderthal values overlap with the low or 'rapid' end of modern human ranges. The discovery of a partial permanent maxillary dentition of a juvenile from the Obi-Rakhmat Grotto in Uzbekistan represents an additional rare opportunity to assess dental development in a Paleolithic hominid. Metric and morphological analyses of the dentition suggest strong similarities with Neanderthals. The purpose of this study is to assess if the duration of development and age at death in this individual supports the proposed 'rapid developmental profile' based on dental evidence from other Neanderthals. Long-period incremental features observed on casts of the tooth crowns and roots were quantified using stereo microscopy, and the duration of crown formation and root development were estimated using cuspal formation times and a range of periodicity values from a large sample of modern human histological sections. Age at death was estimated using modern human initiation ages; these were added to crown and root formation times. The results show that the numbers of long-period lines (perikymata) on the majority of cusps from the six tooth crowns are lower than mean values of a modern human population from Northern England. Assuming the long-period line periodicity of this individual fell within the most common range of a modern human distribution, and that the Obi-Rakhmat Grotto hominid is confirmed to be a Neanderthal, these results are consistent with other studies that suggest Neanderthals may show slightly shorter periods of crown formation than some modern human populations. However, these perikymata numbers do overlap with the lowest known modern human values, showing the greatest similarity with sub-Saharan African populations. The maximum likely age at death of this individual was estimated at 8.8 years, although it is more likely to have been closer to 8.1 years of age. Published modern human developmental standards based on the degree of crown and root formation would suggest an age at death of the Obi-Rakhmat juvenile of approximately 9 years old. In summary, this individual is likely to have exhibited a slightly more accelerated developmental schedule than a large sample of European modern humans. This research was supported by the Max Planck Society.

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A role for sexual selection in the evolution of the human face?

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Although the concept of sexual selection in our species has been introduced originally by Darwin, only in last the two decades, with the development of the computer graphics, it became possible to reveal the biological bias in the perception of sexual dimorphism of the human faces. The recent developments of geometric morphometrics have supplied statistical methods for estimating quantitatively and qualitatively the degree of sexual dimorphism in human faces and crania. This technique allows to decompose the face and skull geometrical shape space in a set of independent components (Principal Warps, PW) which can be used as an orthonormal base for extracting the shape deformations (expressed as a linear combination of PW) which are significantly correlated to the gender. In this way we evidenced the meaningful differences in shape between male and female faces or skulls which have the higher load in discriminating sex. We have moreover tested the possibility that the geo metrical differences in the faces of the two sexes can be interpreted as the result of a canalization process of the sexual dimorphism qualitatively determined during the period of coexistence of our species with populations of Homo neanderthalensis. The geometrical analysis showed that human male crania are morphologically more distant from the Neanderthal shape than human female crania. A further step in this study consisted in morphing digital images, and allowed us to generate "average" virtual faces which then were used to test face-perception mechanisms in our species. With a software of morphing 2D, purposely developed for the present study (GTK-Morph, A.C.G. Mennucci 2000-04), we produced an average human face, starting from a human sample of 40 real faces. Moreover, the average human face (not perceived unequivocally as male or feminine) was transformed geometrically, by means of morphing, away from the Neanderthal average cranial shape and toward sapiens average sh ape. Noteworthy, this geometrical transformation was perceived as more masculine than the inverse transformation (i.e. toward Neanderthal and away from sapiens cranial shape). By this way, our preliminary evidences indicate that the sexual dimorphism of the human faces is, at least in part, the result of the action of selective processes, on sexual base, which happened before the affirmation of our species as the only living representative of the genus Homo.

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Handedness in Neanderthals

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This poster will present a summary of currently known data for left- and right-handedness in Neanderthals. The evidence comes from fossils and lithics from Neanderthal individuals and sites. In addition, we present results from archaeological experiments as well as ethnographic practices which provide behavioural parallels. The relevance of these data for the evolution of language in the hominin lineage is discussed.

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Late Pleistocene Vegetation of NE-Peloponnese (Basin of Phlious), Greece

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Results of sedimentological and palynological analyses and 14C dating of organic lake sediments of a transect through the Basin of Phlious, west-southwest of Corinth (NE-Peloponnes, Greece) provide a record of five moist and temperate phases, rich in predominantly deciduous Quercus and Pinus with minor representation of other deciduous and evergreen trees including evergreen oak and shrubs, interrupted by five drier and cooler episodes representing major parts of Marine Isotope Stage (MIS) 3 (Urban & Fuchs, 2005).

The pollen record shows rapid alternation between warmer instadial phases and colder stadial episodes characteristic of Dansgaard-Oeschger cycles (Dansgaard et al., 1993), and, as such, shows marked similarities to the climatic oscillations reflected by the δ18O record of the Greenland Ice Core Project (GRIP) (Johnsen et al., 2001). Assuming a mean sedimentation rate of about 50cm/1000yrs deduced by 14C data calibration (Hughen et al., 2004), the documented Pleistocene pollen record of Phlious core A 11 (700 cm -1470 cm) spans approximately 15,000 years. Pollen data of the thirteen local pollen zones reflect the period of about 40,000 cal yrs BP to about 55,000 cal yrs BP with a resolution of ca. 350 years, spanning a major part of MIS 3.

Regional response to the extreme climatic events of millenial-scale during MIS 3 in the basin of Phlious is provided by tree species predominantly deciduous and evergreen oak and shrubs like Juniperus as well as by Artemisia and grass populations. In contrast to observations made at Tenagi Philippon and at Kopais, where temperate tree populations were almost eliminated during HE 3 and 4 and in agreement with findings from the Ionnina basin (Tzedakis et al., 2002, 2004), temperate tree populations persisted within the region of Phlious during the recorded parts of MIS 3. It is assumed that the sheltered position within the intramontane basin of Phlious in southern Greece seems to have buffered mediterranean tree population from extreme environmental effects, creating a refuge area even for evergreen tree species during climatic deterioration of the last glacial period.

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The temporal bones from La Quina (Charente, France)

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While Neandertals are certainly the best-known extinct hominid lineage, intra- and inter-population variation is still badly known. This is mostly due to the scarcity of fossil records, which include geographically and temporally scattered fossils. Within this background, the discovery of several individuals in a single site, which can be anatomically compared, provides the unique opportunity to assess intersexual and individual intra-populational variation. The site of La Quina (Gardes-le-Pontaroux, Charente, France) has yielded a series of Neandertal human remains were mostly discovered during the first half of the 20th century. Among them, two well-preserved crania with bothe of the temporal bones (LQ5 and 18) and two isolated temporal bones (LQ10, 27) were recovered. Three of these individuals are adults and were found on the alluvial lower beds of the sequence, which probably belongs to the OIS 4 and yielded a Quina-type Mousterian. A reconsideration of the morphological and metrical features of these bones allows us to focus on individual variability. It also reveals some pecularities which singularize them among the Neandertals. These three temporal bones share a very short squama with a regular and strongly convex parietal edge. The length of their squama corresponds to the lower limit of the neandertal sample whereas their heights are well within the neandertal variation. Furthermore, they all exhibit a crest-type supram eatal spine and depression, which is the predominant form in the Neandertal sample. But above all, the temporal bones from La Quina all show two foramina in the mastoid area which we observed in only 14% of the others Neandertals. This feature is also found on the immature cranium (LQ18). Our observations, albeit tenuous, should constitute some evidence of a “La Quina specifity” among the Neandertal lineage.

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The Okladnikov Cave hominids - the easternmost Neanderthals?

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Between 1984 and 1987, the Institute of Archaeology and Ethnography of theSiberian Branch of the Russian Academy of Sciences excavated Okladnikov Cave in the northern foothills of the Altai mountain range. Besides a diverse fauna and a lithic industry very similar to the European Mousterian fragmented hominid remains were also found. These remains are among the very few pre-Upper Palaeolithic human remains from northern Asia, and thus are of great importance for the understanding of the peopling of this region, as well as migrations, as this area represents one of the possible routes between the Near East/Caucasus and East Asia. Also, if the Neanderthal affinities of these remains can be proven, then the known geographic range of Neanderthals would be expandedeastwards by about 2000 km.Previous studies concentrated on the dental remains, but disagreed as to their affinities. According to Turner they are Neanderthal-like, most similar to the Shanidar material, while Shpakova saw in them modern humans, with certain “genetic traces of Asian Homo erectus”.

Most of the human remains originate from Stratum 3 of the rockshelter, for which several 14C dates and a U/Th date are available. There is considerable variation among the dates, two 14C dates and the U/Th date indicate an age of about 40 ka, while three 14C dates range between 16 ka and 28 ka. Layer 7 delivered two U/Th dates of about 45 ka, Layer 2 14C dates of 38 ka. Direct dating of the subadult distal humerus from Stratum 3 yielded a 14C date of 29 900 +- 500 years. The remains consist of five isolated teeth and four postcranial fragments (an additional specimen, a patella is mentioned by Alekseev (1998), but its wherewithals are unknown). The dental remains, a lower P3 (Stratum 7), a lower dm2, a lower M1 and two lower M3s belong to at least three individuals. The teeth show archaic traits like a very complex occlusal pattern and a large anterior fovea, but no derived Neanderthal traits like an uninterrupted mid-trigonid crest, or strong taurodontism. All teeth are rather small, and fall in the lower half of the Neanderthal range of variation.

Four postcranial fragments were recovered, an adult manual middle phalanx, a distal humerus fragment (Stratum 2), and a subadult distal humerus and distal femur. The subadult fragments are assumed to belong to the same individual, as they are of comparable developmental age and originate from the same stratum and neighbouring squares. The morphology of the postcranial remains in general is rather archaic. The phalanx is strongly flattened, with a very broad distal end, similar to Neanderthals and middle Pleistocene Homo. The adult distal humerus is small with low trochlear depth. It has a relatively small olecranon fossa. The medial epicondyle is small, and does not deviate strongly dorsally. The immature remains are very fragmentary, and do not preserve too much morphology. We estimate the age of this individual at about 6-8 years, based on comparison with a sample of medieval to recent children from Austria. Compared with similar sized recent humeri, the medial pillar limiting the olecranon fossa is relatively thin, while the cortical bone at the level of the nutritive foramen is very thick. The femur also shows relatively thick cortical bone, and a marked linea aspera with a slight pilaster.

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New interpretation for Neandertal extinction

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Neanderthals are certainly the best known fossil hominid group. At the same time many aspects of their history are still misunderstood and especially their extinction and taxonomic relations with modern humans. There are two schools on this topic: the first one considers Neanderthal and modern humans as two distinct species and the second considers them as one single species, with or without two subspecies. In this study I propose a new way of understanding the relationships between those two human groups. The variation of numerous characters (e.g. clavicle morphology; thorax breath, high of the skull, occipital region morphology, occipital torus,) within Neanderthal populations shows a west to east gradient. From west to east, characters become less and less "Neanderthal" and more and more "modern". In other words, the more the individuals come from the western part of Europe, the more their characters become Neanderthal. Moreover, in central Europe and in the Near East, post-Neanderthal populations still display Neanderthal features (e.g. supra-iniac fossa, shape of the mandibular foramen, axillary scapular border, supra orbitary torus, occipital bun …), which is not the case in western Europe, where no convincing evidence of hybridisation between them and Neanderthals has been found. In other words, when modern humans spread into Europe 40 000 years ago, interbreeding was complete in the Near East and less and less so toward the west until gene flow stopped between the two populations. This hypothesis implies that the ancestors of Neanderthals arrived and evolved in Europe, a geographical dead end, at a time when gene flow between western and eastern European populations was very limited, and even sometimes interrupted. Hence, Near East Neanderthals could not be interpreted as the result of a migration of a Neanderthal population toward the East, but as a continuum in space and over time between two human groups. This interpretation allows us to explain why Near Eastern Neanderthals look so modern, and may settle the discussion about the existence or the absence of Neanderthals in the Near-East. In conclusion, systematic relations between Neanderthals and modern humans are far more complex than previously thought and can be interpreted in terms of speciation by distance between two populations. This new hypothesis may be tested in other regions in the world, especially where there are geographical cul-de-sac like Indonesia.

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Endostructural characterisation of the Regourdou 1 Neandertal proximal arm: bilateral asymmetry and handedness

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Cross-sectional properties of long bone shaft are commonly used in (paleo)anthropology for reconstructing mechanical loading histories related to locomotion, subsistence strategies, manipulative behaviors, etc., recorded in bone structural morphology during growth. Available evidence proves that substantial functionally-related changes in diaphyseal morphology of the human upper limb occurred through the Pleistocene (Ruff et al. 1993). Notably, a significant degree of bilateral asymmetry, likely related to unilateral activity levels and preferences, has been recorded on the Neandertal proximal arm. In this respect, the Neandertal figures tend to approximate the pattern of pronounced functional asymmetry displayed by trained tennis-players (Trinkaus et al. 1994). The Regourdou 1 Neandertal partial skeleton from Montignac-sur-Vézère, Dordogne, France (OIS 4) preserves skeletal elements from both upper limbs suitable for accurate morpho-structural comparative analysis and functional interpretation. Previous external morphological and dimensional analysis of this young adult individual has shown right side hypertrophy (Vandermeersch and Trinkaus 1995). By means of synchrotron radiation microtomography (SR-μCT, scans at 350 μm), we have characterised the endostructural organisation and cross-sectional geometry of its right and left humeri in order to precise the polarity and the amount of functional asymmetry and handedness. For the purposes of the study, the following parameters have been assessed: cortical thickness and volume, cortical and medullary areas (CA, MA), second moment of area (I), Ix/Iy and Imax/Imin ratios, polar second moment of area (J), and CA, MA, Imax/Imin, J degree of asymmetry. Bidimensional variables have been measu red/ calculated respectively at 35%, 50%, and 65% of the humeral length. As a whole, this noninvasive investigation supports previous conclusion that Regourdou 1 was right-handed. Nonetheless, while a greater strength to compression, flexion, and torsion is shown by the right humerus, compared to the currently available Neandertal figures (based on radiographic record), this individual presents only a modest degree of right dominance. Interestingly, the high resolution 3D-mapping of the cortical bone volume documents an heterogeneous topographic pattern of structural asymmetry along the humeral shaft, mostly affecting its distal portion. Research developed within the EC TNT project (http://www.the-neanderthal-tools.org) in collaboration with the Musée d'Art et d'Archéologie du Périgord, Périgueux, and the European Synchrotron Radiation Facility, Grenoble.

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Virtual Synthesis of the Skull in Neanderthals by FESS

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The measurement of strains in real skulls is an inductive method that yields information about the stresses occurring in the a priori existing shape. In contrast, the approach taken here to determine the relationship between skull function and skull shape applies Wolff`s law through a deductive technique of structure synthesis. This poster describes the application of this method in the virtual synthesis of a Neanderthal skull.

An unspecific homogeneous solid is first constructed, giving the stresses ample volume to spread between points of force application and constraint. The FE-software ANSYS 9.0 is used to form 10-noded tetrahedral finite elements with a maximum of 129,000 nodes. The initial conditions are the functional spaces for the brain, the eye openings, and the nose cavity. Further initial conditions are the muscle forces, and the placement of the dental arcade, including assumed bite and chewing forces. Enforcing equilibrium of forces, the primary 3D stress flows in each load case are summarized by a physiological superposition, which accumulates the highest value of compressive stress in each finite element. If the stress free parts are eliminated and the summarized stress flows are maintained, a reduced model appears, which is very similar to the real skull. This reduction of shape can be repeated iteratively and leads to a more exact form. The final FE-model is presented by using the CAD-software CATIA V5 and the resultant cross-sections are compared with CT-scans of a real Neanderthal skull reconstruction.

Changes in the form of the dental arcade, its position relative to the braincase, the origins of muscles, or the volume of the brain lead to models that clearly resemble morphological differences between species or genera.

The deductive virtual synthesis of the typical skull of Neanderthals using the finite-element structure synthesis (FESS) demonstrates the direct correlation between functional loading and the biological structure and shape and can be used to test hypotheses regarding the relationship between structure and function during skull evolution.

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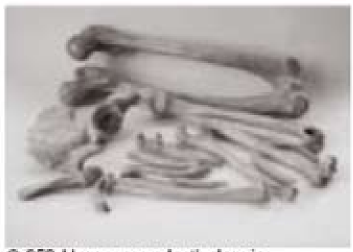

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Museums and Field Trips

Rheinisches LandesMuseum Bonn

Colmantstr. 14-16 D-53115 Bonn

Secial exhibition: Roots // Wurzeln der Menschheit
July 8-November 19, 2006

To mark the 150th anniversary of the discovery in 1856 of the Neanderthal Man in the valley of the same name just outside Düsseldorf, the Rheinisches LandesMuseum Bonn and Landschaftsverband Rheinland have put together an exhibition called 'Roots//Wurzeln der Menschheit', which will run from July 8 to November 19, 2006.

When the Neanderthal skeleton was uncovered 150 years ago, nobody could have guessed just how significant the discovery would prove to be in the ongoing discussion on the evolution of man. Ever since the former Provinzialmuseum Bonn purchased the find in 1877 for 1000 gold marks, thus preventing its sale abroad, the Neanderthal man's remains have been located at the Rheinisches LandesMuseum Bonn/ Landschaftsverband Rheinland.

Meanwhile, 150 years of historical research have taken place. The organisers at the museum are taking this as an opportunity to assemble an exhibition of original, preserved skeletons and skulls of various early and prehistoric people from Africa, Asia and Europe. This will be the first exhibition of its kind, anywhere in the world.

The exhibition begins with the ideas of the origins of man that prevailed until well into the nineteenth century. It is apparent from the many myths of creation that originated in Africa, Asia and Europe, that almost without exception, man was conceived as having a static appearance, one that continued unchanged throughout his history.

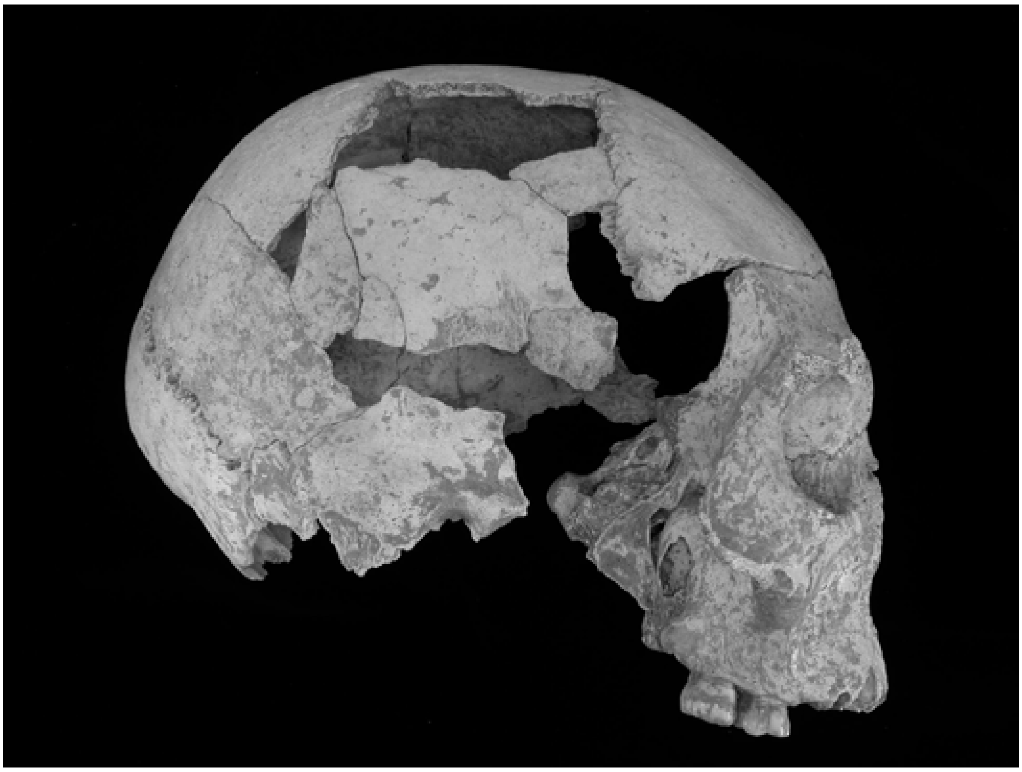
In contrast, the revolutionary knowledge that evolutionary research has afforded us, has taught us, that human development was indeed a dynamic process. It is for this reason that the subject of human evolution – and the Neanderthal Man in particular – has been taken as the central theme of the exhibition.

The history of man's development is presented in chronological sequence and in accordance with the most recent research findings. It begins with the first primates, from which group modern man originated, traces their development until they began to walk upright – a step that took place at a time when our ancestors were still apes – and on until the evolution of what can be defined as early humans, with their larger brains, who were capable of thinking and handling accordingly, finally ending with the development of modern man.

The exhibition also shows how the first people spread out from the African continent (Out of Africa I) and what happened subsequently, how separate, regional developments took hold that led to the formation of specific types, such as the Neanderthal Man in Europe or the extremely small-statured Flores Man in Indonesia.

The classical Neanderthal skeleton from 1856 with the additions from 1997

However, the main point of interest remains the Neanderthal Man, who is preserved at the Rheinisches LandesMuseum, as well as his close relatives. The most recent, and indeed spectacular, research on the life of the Neanderthal during the



The skull of an early European Homo sapiens from Pestera cu Oase in Rumania (about 36Ka)

period of 120,000 to 30,000 before today, a time that was characterised by great climatic deviations, is also presented in a comprehensive and well-illustrated manner.

The exhibition ends with the second wave of migration (Out of Africa II). Here, modern man, who evolved more than 200,000 years ago in Africa, begins to take possession of the earth. His perception both of himself and of his environment leads to changes in living strategies, expressed in funeral piety and the first works of art.

Further information is available from: www.rlmb.lvr.de and www.roots2006.de

Neanderthal Museum

Talstrasse 100, 40822 Mettmann

Neanderthal Museum – Home of the most famous German

One of the most popular and most modern museums in Europe is situated near the ground where the most famous German was discovered 150 years ago: Neanderthal Man. This world-historic place invites its visitors to go on a time travel through the history of mankind – from the very beginning in the African savannah more than 4 million years ago until today. The new museum has welcomed more than 1.7 million visitors since it was opened in 1996.

The museum´s permanent exhibition and architecture have won several national and international awards.

The Feldhof Cave, in which the relics of Neanderthal Man were found in 1856, is lost forever due to limestone quarrying. An approach towards the past landscape was enabled through the archaeological excavations in 1997 and 2000. Landscape architects have redesigned the area and have created an archaeological park.

Temporary Exhibition
Hautnah. Neanderthaler – Close Contact. Neanderthals
4 May to 24 September 2006

The Neanderthal Museum takes a closer look at the common image of Neanderthal Man in public and in the scientific realm. This image has been made up of the same stereotypes for 150 years now: Bended posture and a club.

The exhibition confronts the cliche of the wild man with individual life stories of Neanderthal people. Every stage of life is represented by the history of one particular find. Topics include death and dying, the way people looked like, illnesses and causes of death.

Finally, a very special attraction is expecting the visitors:

They can have themselves morphed into a Neanderthal man and take home as their personal Neanderthal portrait.

On occasion of the temporary exhibition the Neanderthal Museum presents the first full reconstruction of the Neanderthal find from the Feldhof Cave. He welcomes the visitors in the foyer.

Westfälisches Museum für Archäologie Landesmuseum

Europaplatz 1, 44623 Herne

„Klima und Mensch. Leben in eXtremen“

climate and mankind. life in eXtremes

May 30th 2006 - May 30th 2007

The special exhibition “climate and man. life in eXtremes” in the Westphalian Museum for Archaeology in Herne deals with the question how the evolution of the climate is connected with the evolution of humans, animals and plants. The exhibition has an unusually wide chronological scope from 6 million years ago until today.

The latest research results indicate an imminent extreme climatic change. However, the climate has never been steady. Animals, plants and humans always had to adapt to their surroundings in order to survive. How will the climate develop in-between natural processes and man-made influences?

At the beginning of the exhibition the visitors get to know what climate actually is, why it changes and how the climate of the past can be reconstructed. Here, they learn how researchers gain their information from the bottom of the sea or from the highest strata of the Earth’s atmosphere.

In the 900 m^2 measuring special exhibition hall the visitors – lead by the climate curve – wander through the past 6 million years until they reach our present time. Over 800 important exhibits from all over the world – from 1.8 million years old stone tools from Africa to the modern UV-protection-clothing from Australia – illustrate the confrontation between humans and their environment. Neanderthal man and early modern man form the centre of the exhibition: these human types managed to adapt even to the extreme climatical fluctuations which took place between 130 000 and 9600 BC.

In a designed landscape the visitors pass fossilized leaves which fell during an autumn 130 000 years ago. They meet huge mammoth skeletons, a sabre-toothed cat and the mummy of the mammoth baby “Dima”.

Dima - baby of *Mammuthus primigenius*

Eight separate rooms show – partly by unique finds – how humans reacted on their environment: burned bones from the world’s oldest fireplace mark the beginning of the use of fire as an element, which very soon became indispensable. Another topic is hunting. Here, the world’s oldest hunting weapons will be displayed: a 400 000 years old spear from Schöningen, the 125 000 years old lance from Lehringen and the 9000 years old bow from Holmegård in Denmark.

In modern times the dependence of humans on climate and environment seems to be dissolving and has changed. Now, man himself exerts influence on these aspects: economy and urban development change the face of landscapes, their water balance and thermical cycling. Humans burn wood, petroleum and coal in hardly imaginable amounts and set free gases, which might trigger unpredictable reactions in the complicated network of the climatic system of the Earth.

The final part of the exhibition shows examples for different reactions to todays climatic change and even hazards a look into the future. What will the climate of the future be like? There are numerous possibilities, but one thing is certain: the strong connections between climate and humans.

www.landesmuseum-herne.de

www.klimaundmensch.de

Westfälisches Museum für Archäologie Landesmuseum

Europaplatz 1, 44623 Herne

**searching. finding. excavating.
the permanent exhibition**

The Westphalian Museum of Archaeology in Herne is the central showcase for archaeology in Westphalia. It invites the public to get to know the most important discoveries of almost 200 years of archaeological research in Westphalia.

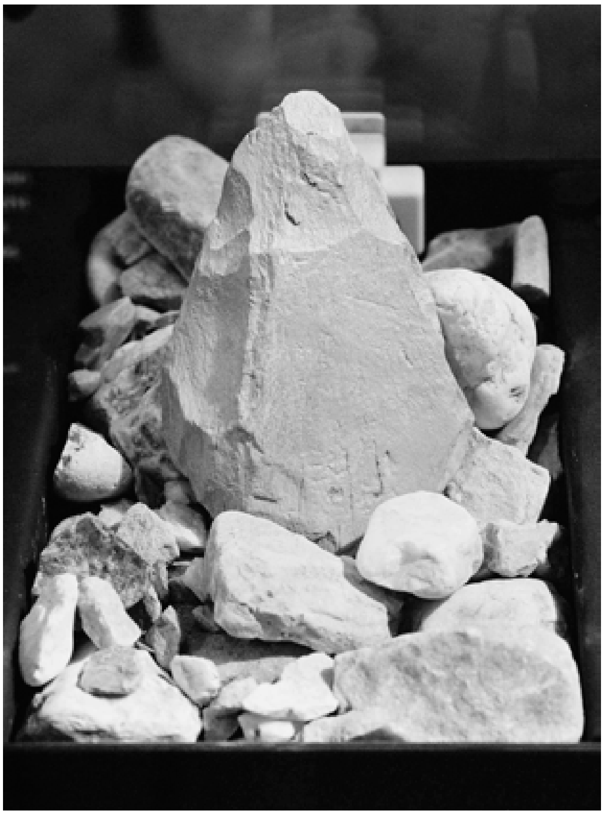
Excavation has been chosen as a basic element of design for the museum. The architecture adopts this image by locating all exhibition areas under ground. This theme is logically developed in the design of the permanent exhibition which resembles one gigantic excavation site. Many objects are returned to the ground again within an artificially shaped topography to become understandable within the context in which they were found.

The circuit through the excavation site is built up chronologically and a walkway, 210 metres in length, allows access to the exhibits. The walkway serves as a time line leading us to the many major and minor stories of the past which can be discovered left and right of the walkway. The most important information and finds are situated directly beside the walkway.

The way through the excavation site is lined by brightly lit tents. They imitate the protective shelters used at excavation sites. Just one or two archaeological objects are in the centre of each of these excavation tents. Here, the visitors are invited to deal with one topic with all their senses.

Another important part of the exhibition is the research laboratory, where visitors can come to understand the methods by which scientists decipher the traces of the past. The starting point are human skeletons and scattered bones which were found in a megalithic grave near Warburg. A section of the grave has been re-built in the centre of the laboratory. It consists of the remains of the dead and their gifts for the afterlife such as amber jewellery, stone tools and ceramic bowls. The task is to discover as much as possible about these people and their environment, by using, for example, historical and archaeological, medical, physical and chemical methods.

Our guided tour follows traces which have been left behind by humans in Westphalia during the last 250.000 years. In just one hour we pass through history, for example, through the period of the Neanderthals, see monumental graves and the remains which were left behind by the early farmers. Evidence of early Christianity and of medieval life are further important stops on the way to our present time.



Hand axe made from mammoth bone

E-Mail: archaeologiemuseum@lwl.org
URL: www.landesmuseum-herne.de

DEUQUA- Excursion: Late Glacial Volcanic Field in the Eastern Eifel

Environmental impacts of the Lateglacial eruption of the Laacher See Volcano, 12,900 cal BP

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The Laacher See Volcano (LSV), 40 km south of Bonn, explosively erupted ca. 6.3 km^3 of strongly compositionally zoned phonolite magma during spring, 12,900 years ago. This is one of the major Late Quaternary Plinian eruptions of highly evolved magma in central and southern Europe. The bulk of Laacher See Tephra (LST) was deposited east of the LSV, within the Neuwied Basin. The characteristic chemical (alkali-rich phonolite) as well as mineral composition (amphibole, clinopyroxene, alkali-feldspar, plagioclase, phlogopite, haüyne and titanite) are the reasons why the LST is easily distinguished from Lateglacial Icelandic tephra. LST is the most important stratigraphic marker in Lateglacial deposits in central Europe. The eruption, in turn, had a major impact on the environment on the ground as well as in the atmosphere during the eruption and for decades thereafter.

Eruptive history

Environmental controls on the eruption include the complex interplay between magmatic processes and crustal lithology and stratigraphy, tectonic grain, aquifer location and water supply as well as eruption-induced environmental processes such as repeated vent widening and constriction/ collapse, downward vent erosion and lateral vent migration. Most likely, humans and animals were warned by numerous precursory earthquakes, and left the area. There is no evidence that any eruptive activity preceded the climactic eruption of the LSV in 12,900 BP. However, tracks of capercillie, brown bear, horse and red deer have been uncovered during pumice mining in a layer deposited prior to the uppermost tephra (Baales and Berg, 1997).

The eruption began with a phreatic to phreatomagmatic blast followed by a lower Plinian fallout stage, a medial phreatomagmatic stage characterized by vent migration and multiple collapse of the eruption column, an upper Plinian stage and a terminal phreatomagmatic stage most likely triggered by groundwater entering the partly emptied magma chamber. The resulting Plinian eruption columns reached at least 30 km in height. The SW-NE-direction of the main fallout lobes probably reflects the main tropopause wind direction at that time. The alternating Plinian and phreatomagmatic stages produced widespread fallout lapilli and ash deposits as well as proximal to medial base surge and pyroclastic flow deposits. The Laacher See crater (2 x 2,5 km^2) was formed by vent erosion and collapse. Tephra thickness decreases to 10 m at ca. 5 km from vent and to 4 m within the eastern Neuwied Basin. The extremely high mass eruption rate of 3-5 x 10^8 kg/s during the major Plinian fallout phases suggests that the bulk of the magma volume (c. 64 %) was erupted in c. 10 hours. The main phase of LSE (lower and upper Plinian stage, initial and medial phreatomagmatic stage) may therefore have lasted a few days altogether. Several weeks elapsed between the end of the second Plinian fallout stage and the second half of the terminal phreatomagmatic stage. A second significant time break close to the end of LSE could have lasted a few months.

To the northeast, the Laacher See Tephra can be traced as far as southern Sweden limited by the Lateglacial ice boundary (1100 km), to the east as far as Poland, to the south as far as northern Italy (600 km) and to the west as far as central France. The LST has been discovered in cores obtained from many lakes in central Europe, the southernmost lake being Lake Geneva, the northernmost Haemel See in northern Germany (Merkt and Müller, 1999). Ash-layers of LST have also been found in peat bogs, alluvial deposits and soil profiles over an even wider area.

Age of Laacher See eruption

The initial radiometric date of c. 11,000 ^{14}C BP determined on plant material incorporated within the LST layer, made shortly after Libby invented the ^{14}C dating method (Firbas, 1953), has essentially been confirmed by many subsequent radiocarbon age estimates (summarized in Bogaard and Schmincke, 1985; Friedrich et al., 1999). Single crystal laser fusion dating ($^{40}Ar/^{39}Ar$) on sanidine phenocrysts indicate an age of 12.900$\pm$560 a BP (Bogaard, 1995), practically identical to the results of recent varve studies of maar deposits west of the Laacher See (Brauer et al., 1999) and of other lake sequences (Merkt, 1991). An age of ca. 12.900 a BP is now accepted by most.

Archeological findings in the strata beneath the LST indicate that the Laacher See area was inhabited at the time of eruption (Bosinski, 1983). The LSE was most likely witnessed by human populations. However, no unequivocal remains of human victims of the eruption have been detected so far, despite the removal of pumice to the underlying soil in hundreds of pumice pits. Precursory phenomena, such as strong seismic unrest and/or increased gas emissions, may have been so traumatic that living beings evacuated the immediate surroundings of the eruptive site (Schmincke et al., 1999).

Season of the eruption

The volcano erupted during the late spring - early summer as reflected in several independent lines of evidence. Firstly, late spring is indicated by the seasonal development of plants directly overlain by LST (Schweitzer, 1958). Secondly, the LST is found above the winter-, but below the summer-layer in several lakes in Germany (Merkt, 1999). Thirdly, the presence of a summer carbonate layer immediately above LST in lake deposits of the Steislinger See (southern Germany) indicates tephra sedimentation prior to June (Schneider, pers. comm.). Finally, Laacher See ashes were deposited in two separate graded layers in the Black Forest lakes Titisee and Mummelsee, further indicating that the LSV erupted later than early spring (Merkt, 1991), because tephra deposited on a frozen lake surface would not have settled in two well-developed graded layers after melting of the ice on the lake surface, but in a more massive, mixed ash bed.

Initial blast

The deposits of the LSE early phase directly overlie the pre-eruptive ground surface, which at that time was covered by meadows and open forests, mostly willows and birch trees (Fig. 16). The rate of magma ascent was initially low and the initial eruptive mechanism was strongly influenced by water-magma interaction inhibiting significant magmatic degassing. The area surrounding the Laacher See Basin was struck by a pressure blast up to 250°C in temperature that defoliated and felled trees. The successive mass flows and base surge clouds covered the devastated landscape with a mantle of steaming green mud. The immediate vicinity of the vent was also bombarded by a hail of large ballistic blocks. The environmental impact of the opening phase of the LSE was restricted to the immediate vicinity of the Laacher See Basin (Schmincke et al., 1999).

Lake formation and catastrophic dam burst

Within the zone of major devastation (c. 1400 km^2) up to c. 36 km southeast and up to c. 58 km northeast of the LSV, the Allerød landscape with its fauna and flora was totally destroyed. Pyroclastic flows extended more than 10 km from the vent towaerds the north and the southeast. Close to the Laacher See crater, copious tephra deposits drastically altered the local morphology and drainage patterns. A temporary tephra dam formed at the bottleneck outlet of lower Neuwied Basin (Andernacher Pforte) during the closing stages of the LSE (Park and Schmincke, 1997). A large temporary lake formed as a result of the rapid deposition of c. 0,43 km^3 of primary fallout tephra, with abundant pyroclastic flows entering tributary valleys, while a major dam completely disrupted the Rhine River. Thick deposits, clearly reworked by fast-flowing water, overlie areas occupied by dry land prior to the LSE, as indicated by molds of rooted trees and shrubs. A characteristic bed interpreted as stranded pumice rafts originally floating on top of an extensive water body indicates that the depth of the temporary lake must have reached more than 15 m above the pre-eruptive land surface. It filled the entire Lower Neuwied Basin between Andernach and Koblenz (c. 140 km^2), reaching far into tributary valleys and probably also upstream into the Upper Middle Rhine and Moselle valleys . The lake volume (at least 0,9 km^3) could have been accumulated within c. 4-5 days, given present-day discharge rates for late spring/early summer. The actual damming of the lake probably lasted several weeks, however, because the dam, which grew simultaneously with the rising water level, certainly was not completely sealed. Pronounced erosion on the lower basin floor cut channels more than 4 m deep into primary and reworked LST, and even into pre-LST valley-fill, indicating catastrophic drainage of the lake, probably resulting from sudden dam collapse. One or several surge-like flood waves charged with tephra must have abruptly passed from the Neuwied Basin into the narrow lower Middle Rhine Valley. Their deposits occur at least as far north as Bonn, more than 50 km downstream from the dam at Andernach. The damming and drainage of the lake occurred while the LSE was still in progress.

Late syneruptive and posteruptive environmental mass wasting

Following the instantaneous sealing of the sparsely vegetated ground by a blanket of loose tephra throughout much of central Europe, a long period of mass wasting ensued that probably lasted for several decades judging from recent explosive eruptions such as those of Mt. St. Helens (1980) and Mt. Pinatubo (1991). Reworking of unconsolidated tephra deposits over several 100 km^2 began near the end of the terminal phase of the eruption which may have lasted for several months. Erosion and reworking were extensive for several reasons: (a) the landscape was covered by unconsolidated tephra and therefore barren

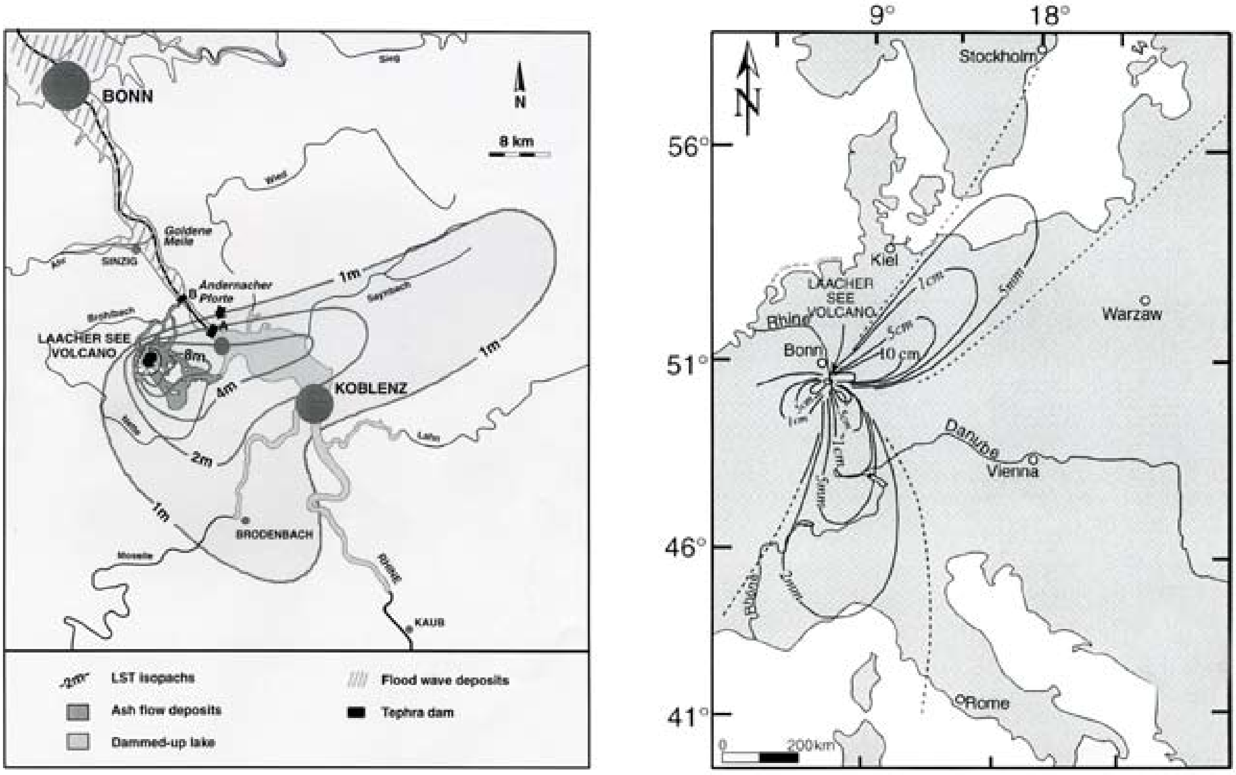

Fig. 1. Map of the area severely devastated by Laacher See eruption: areal distribution of major ash flow deposits, approximate extent of the lake dammed up within the Neuwied Basin and possible extent of the flood waves resulting from the sudden collapse of the tephra dam (after Schmincke et al., 1999), and isopach map of major Laacher See Tephra fans in central Europe (after Bogaard and Schmincke, 1985).

of vegetation; (b) the bulk of the tephra particles had low densities (<1g/cm^3) and were thus easily moved by wind and running water; (c) the eruption probably terminated in late summer to fall, a time of likely increased rainfall. Moreover, prolonged precipitation was apparently triggered by large amounts of fine ash suspended within the atmosphere, judging from the abundant wet ash fall deposits (many layers in the “Hauptbritzbank”). Close to the proximal tephra rim, which was up to 50 m thick, V-shaped gullies were quickly cut deep into the LST deposits. Abundant lahars, flash flood and local lake sediments were laid down in the Neuwied Basin, while distant flood-plain deposits and thick pumice bars formed as far as the Weser River, 150 km east of the LSV (Schmincke et al., 1999). The tributary rivers of the Rhine River (especially the Nette River traversing the greatest primary tephra thickness) were strongly affected by lahars. Landslides of thick slope deposits at the steep scarps of the Neuwied Basin may have been induced by posteruptive earthquakes generated during major crater readjustments. The rapidly reworked tephra deposits exceed 20 m in thickness within the central Neuwied Basin. Within the lower Neuwied Basin, the Rhine River was transformed into a braided-river system which probably persisted for several decades, until the barren landscape was reoccupied by vegetation. Rhine River deposits were strongly dominated by reworked LST material. The re-incision of the Rhine River through thick primary and reworked LST deposits into older alluvium was accompanied by the re-establishment of a meandering river regime.

Climatic impact of the Laacher See eruption

Plinian eruptions of the magnitude of the LSE have a significant impact on climate when their eruption columns enter the stratosphere, the height being a function of the mass eruption rate. The second factor is the amount of total S injected into the stratosphere, which depends on the mass of magma erupted for a given sulfur content and the longevity in the stratosphere of sulfate aerosols. A minimum of 2 Mt total S was calculated to have been released during the LSE, by comparing pre- and posteruptive volatile concentrations in glass inclusions and pumice matrix glasses (Harms and Schmincke, 2000). The most plausible pressure conditions in the Laacher See magma reservoir (c. 1-1,4 kb, Gardner et al., unpublished data), indicate that the melt coexisted with a fluid phase prior to eruption. In view of the high H_2O contents of the magma, which were close to saturation level, a separate S-bearing vapor phase was probably present in the magma prior to eruption. The petrological sulfur estimate is thus likely to be an absolute minimum value for the S-input during the LSE, strengthening the likelihood that the LSE had a major impact on climate. Increased precipitation in central Europe and/or destruction of the vegetation cover for several years is suggested by several proxies, especially by increased sediment supply into lakes.

The vegetation of central Europe may have both suffered from ash fall, acid rain, increased rain fall, reduction of solar radiation and drop of temperature as a result of the climatic impact of the LSE. Kaiser (1993) attributes reduced widths of tree rings in pine-tree stumps found in gravel deposits at Dättnau, near Winterthur (Switzerland), to a drop in temperature that lasted for 6 years and which most probably was induced by LSE.

In many lakes in southern and northern Germany, the sedimentary characteristics of the varves above the LST significantly changed for several years following the eruption (Merkt and Müller, 1999). Bedding and graded bedding in seasonal layers are more poorly developed compared to varves deposited prior to the LSE. The climatic impact of the LSE may have caused a prolonged period of increased precipitation. Increased rainfall may also have accelerated reworking of tephra in the Neuwied Basin. Widespread destruction of vegetation by the tephra blanket may have been another factor. The Younger Dryas cooling period, however, was evidently not triggered by the LSE – as was formerly thought - because it started ca. 200 varve years after the eruption (Brauer et a., 1999; Merkt and Müller 1999; Litt et al., 2001).

Evidence is accumulating that the climatic impact of large volcanic eruptions may last much longer than hitherto thought, e.g. by disturbing patterns of ocean circulation such as following the Pinatubo eruption (1991). No proxies are yet known that would reflect such decadal climatic impact following the LSE.

Is volcanism in the Eifel volcanic fields extinct?

Traces of a second Laacher See eruption have not been found anywhere - neither below nor above the well-documented LST sequence. The only younger volcanic eruption in the Eifel region is that of Ulmener Maar located c. 30 km southwest of Laacher See Volcano (Zolitschka et al., 1995). Its moderately evolved nephelinite tephra layers were found in maar lake deposits, its age being estimated as 11,000 cal BP based on detailed varve studies.

Judging from the eruptive history of two older phonolitic volcanoes in the East Eifel volcanic field, the Laacher See Volcano might erupt again. Renewed eruption of the LSV would no doubt generate phreatomagmatic explosions more powerful than those that occurred 12.900 years ago, and would pose a major hazard for the densely populated and highly industrialized lowland of the Neuwied Basin.

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Deuqua- Excursion: Volcanic Field in the Western Eifel

Vegetation history and palaeoclimatology of the Western Eifel Volcanic Field as inferred from palaeobotanical studies of annually laminated Maar lake sediments

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Location

The Western Eifel Volcanic Field is well known for its maar lakes providing long sediment records of palaeoenvironmental changes. In two of these lakes, Holzmaar and Meerfelder Maar, long successions of annual laminations (varves) are preserved including the lateglacial period, i.e. the transition from last glacial to present interglacial.

Lakes Holzmaar (HZM) and Meerfelder Maar (MFM) are located less than 10 km apart (Fig. 1) at altitudes of 425 m a.s.l. (HZM) and 336.5 m a.s.l. (MFM). The present lake surface of MFM is 0.248 km^2 compared to 0.058 km^2 of HZM. The maximum water depth of both lakes is presently nearly the same (17 to 18 m).

The Lake Holzmaar belongs together with the "Dürres Maar" and "Hitsche Maar" to the Holzmaar group of volcanous near the town of Gillenfeld. They are located along a NW-SE oriented Variscian transcurrent fault. Dürres Maar is located ca. 400 m NW of Holzmaar and has a diameter of 270-300 m and a former depth of 20 m. It contains Lateglacial and early Holocene lacustrine sediments and is covered with a rised bog.

The Hitsche Maar is located 140 m NW of Dürres Maar. With a former depth of 5 m and a diameter of only 60-70 m this maar is one of the smallest in the Eifel region. Today it is hardly recognizable in the surrounding meadows and forms a moist morphological depression. It contains only Lateglacial and early Holocene organic deposits.

Weichselian Lateglacial

For continental sites, annually-laminated, high resolution lacustrine sediments offer great potential for establishing regional stratotypes, based on multi-proxy data sets and an independent chronology. Only with such an approach can we make progress in the precise correlation of events in the continental scale.

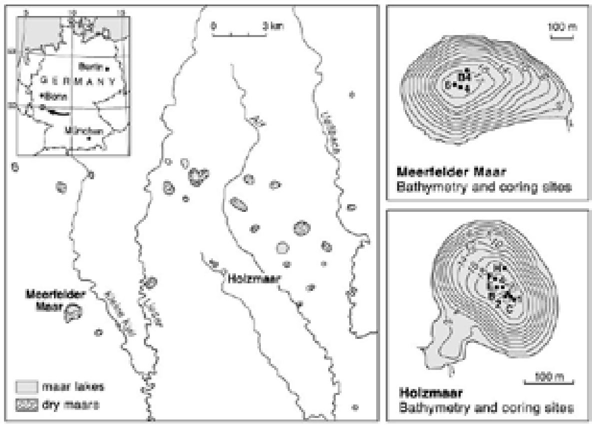

Fig. 1. Location of the Upper Pleistocene maar lakes in the Western Eifel Volcanic Field (after Brauer et al., 2001).

The Meerfelder Maar record is to a large extent annually laminated, providing a long calendar year time scale of 12,000 counted varves. Since varve preservation in the most recent part of the profile is not continuous the established chronology is floating. It has been connected to the "absolute" timescale by tephrochronology. The tephra of the youngest maar eruption in the Westeifel volcanic field, the Ulmener Maar Tephra (UMT), is present in all maar lakes in the region (Zolitschka et al., 1995). It is varve dated in the Holzmaar record, which is annually laminated up to present times, to 11,000 calendar years BP (Zolitschka, 1998). This age has been accepted for the UMT level in the Meerfelder Maar. There, the UMT is found 590 years after the Younger Dryas/ Preboreal transition as defined by sedimentology and palynology (Brauer et al., 1999a). For the same period 600 varves have been counted in Holzmaar thus showing a good agreement between both time scales in this section. The resulting age of 11,590 calendar years BP for the beginning of the Holocene is in good agreement with the generally accepted age of 11,500 – 11,600 calendar years BP (Litt et al., 2001).

The varve chronology from the Meerfelder Maar dates the Laacher See Tephra (LST) at12,880 calendar years BP. In addition, the resulting Lateglacial chronostratigraphy provides information about the duration of pollen zones as defined by plant successions (Brauer et al., 1999b; Litt & Stebich, 1999).

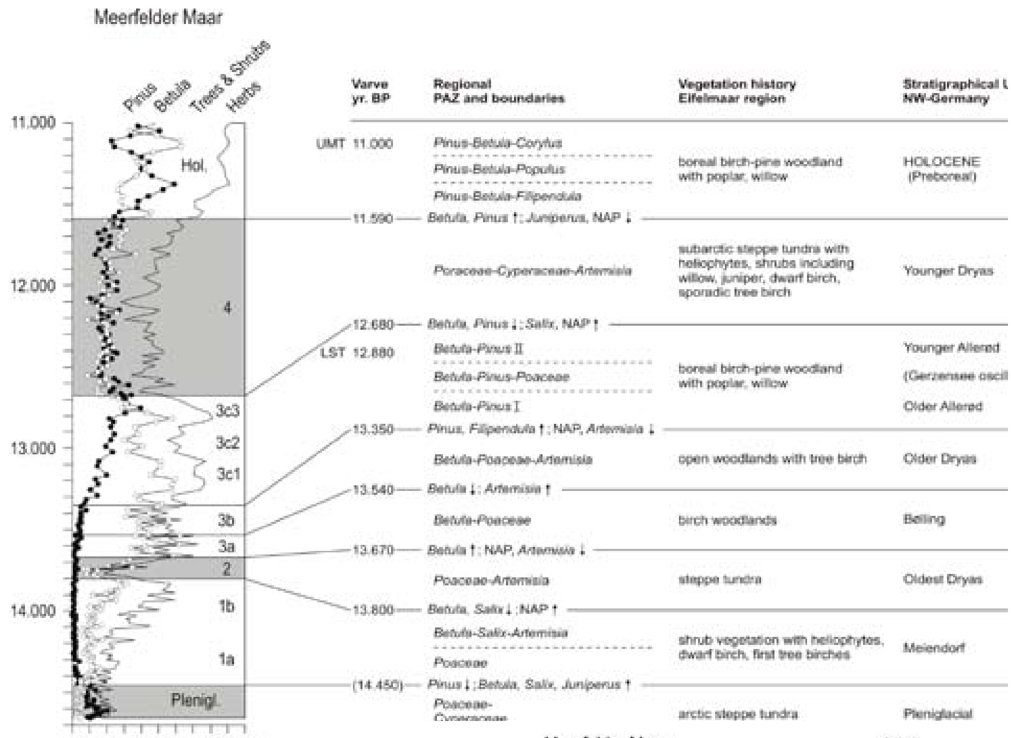

Fig. 2. Meerfelder Maar, Lateglacial sequence. Regional Pollen Assemblage Zones (PAZ) based on varve chronology, vegetation history in the western Eifel region and Lateglacial climatostratigraphic units of northern Germany. LST – Laacher See Tephra, UMT – Ulmener Maar Tephra (from Litt et al., 2003).

The comparison and correlation of oxygen isotope records from Greenland ice cores and biotic signals from continental lacustrine sediments should be made on the basis of independent chronologies in both archives. In addition, it is essential to develop regional biostratotypes on the continents instead of simply using the GRIP core as a stratotype for the Lateglacial even for terrestrial European records as proposed by Björck et al. (1998). In both respects, annually-laminated lacustrine sediments have a great potential (Litt et al., 2001). Only on the basis of such an approach we are able to understand regional environmental and climate variabilities and to recognise “events” for teleconnections.

Holocene

Preliminary results for the development of the Holocene vegetation of the Eifel region are based on investigations of an annually laminated sequence from the Holzmaar lake (core 4/96, see Fig. 4). The Ulmener Maar Tephra (11,000 v.y. B.P.) forms the base of this sequence. This period belongs palynostratigraphically to the Preboreal (zone IV, after Firbas). Birch and pine are the main components in the forests. *Quercus* and *Corylus* invade to the Eifel at that time.

The beginning of the Boreal (zone V) is characterized by an increase of the *Corylus* curve at 10.800 vy BP. *Quercus* and *Ulmus* become abundant whereas birch and pine lose their

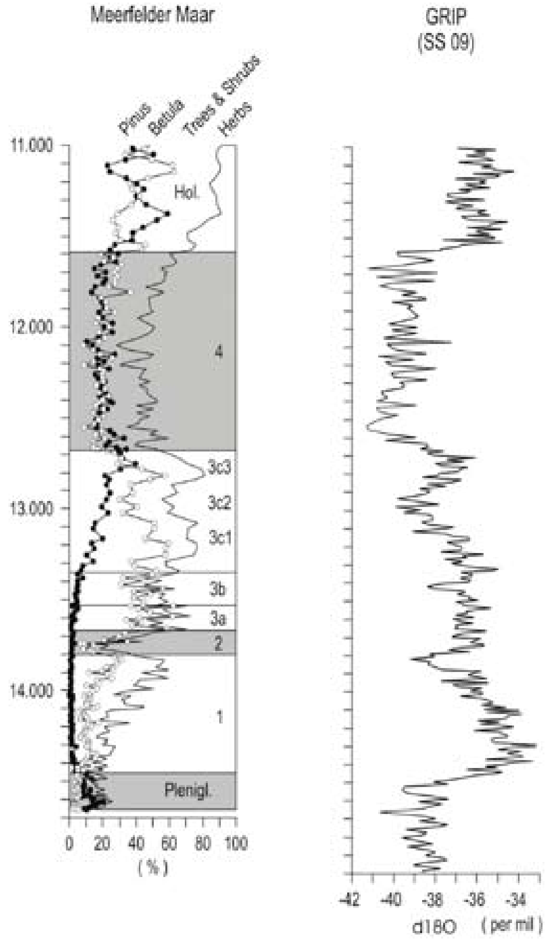

Fig. 3. Correlation of the Meerfelder Maar record with Greenland ice-core record. From the GRIP ice-core the time model SS09 (Johnsen et al., 1997) has been used (after Litt et al., 2003)

competitive edge. *Tilia* immigrates at the end of the Boreal.

The Atlantic (zone VI/VII) is the classical Mixed Oak Forest period (with an increase in *Quercus, Ulmus, Tilia, Fraxinus*), and this time is also the climatic optimum (ocurrence of *Viscum* and *Hedera*). The immigration of *Alnus* starts at the same time. The beginning of this zone is dated by varve chronology at about 8.550 years BP. Around 6,200 B.P. (late Atlantic) small vegetation changes result from Neolithic farming (cereal pollen and anthropogenic indicators such as *Plantago lanceolata* and *Plantago major*).

The Subboreal (zone VIII) begins around 5.600 years B.P. and is marked by the arrival and spread of *Fagus*. Human colonization in the Eifel region during the early Neolithic and the Bronze Age is slight.

The late Subatlantic (zone IX) starts about 2.800 years B.P. with a significant decrease of *Fagus* pollen. Caused by the pre-Roman Iron Age colonization, the vegetation changes drastically. The forest density decreases and the NAP values increase including anthropogenic indicators (cereals, *Gramineae, Artemisia, Rumex, Plantago lanceolata* etc.). The extensive land use lasted more or less continuously through the Roman Period.

During the Migration Period the forest becomes dense again (increase of the *Fagus* and *Carpinus* curves, reduced values of anthropogenic indicators). The region is resettled during younger Subatlantic (zone X, 1,000 v.y. B.P.). However, the regional variability between several cachment areas has to be taken into consideration because, in contrast to Holzmaar, strong anthropogenic signal can be seen in the Meerfelder Maar during the Merowingian period (Kubitz 2000).

The great importance of *Secale* cultivation is striking since early Medieval times. The stronge human influence on the vegetation of the Eifel mountains continues until today. The first *Picea* cultivation occurs 170 years ago.

The great advantage of annually laminated sediments is the high time resolution and chronological precision of natural and anthropogenically influenced vegetation changes. Palynological signals can further be used as marker horizons for correlations of several varvedsequences in a regional scale.

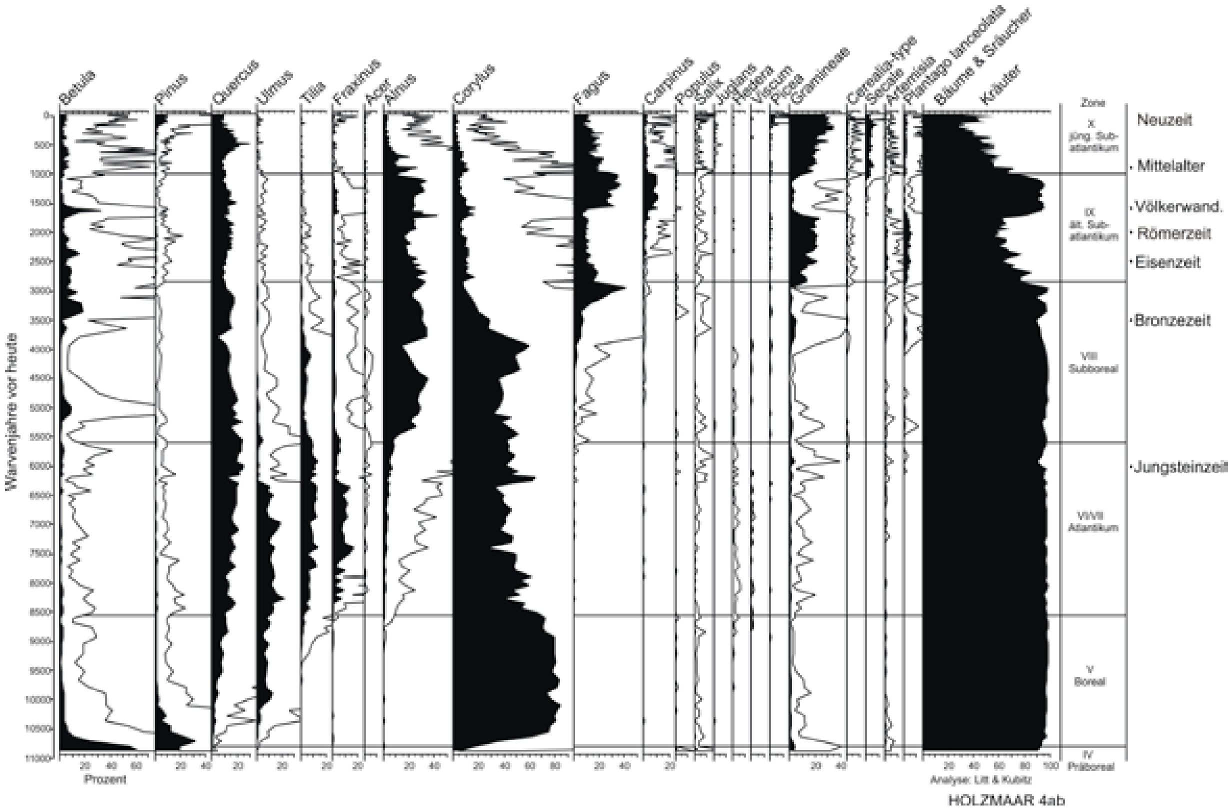

Fig. 4. Holzmaar**.** Simplified pollen diagram from the Holocene part above the Ulmener Maar Tephra (UMT). Pollen analyses by Litt & Kubitz, varve countings by Zolitzschka (after Litt 2004).

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DEUQUA Deutsche Quartärvereinigung

universitätbonn

Alexander von Humboldt Stiftung/Foundation

UNESCO

LVR Qualität für Menschen

DHL

Stiftung Internationale Begegnung der Sparkasse in Bonn

Deutsche Forschungsgemeinschaft DFG

Ministerium für Innovation, Wissenschaft, Forschung und Technologie des Landes Nordrhein-Westfalen NRW.

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