

Makers of the Early Aurignacian of Europe

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ABSTRACT Despite intensive study and a number of remarkable discoveries in the last two decades of the 20th century, our understanding of the cultural and biological processes that resulted in the emergence of the Upper Paleolithic and the establishment of modern humans in Interpleniglacial Europe remains far from complete. There is active debate concerning the timing and location of the origins of the Aurignacian, the nature of the origins of Initial Upper Paleolithic industries (whether by autochthonous development or through acculturation by Aurignacian peoples), the timing of the appearance of early modern humans and the disappearance of the Neandertals, and the relationship of archeologically defined cultures to these different types of hominids. Frustrating our attempts to address these latter two questions is a general paucity of taxonomically diagnostic human fossil material from *early* Upper Paleolithic contexts. We undertake here a review of the human fossil record of Interpleniglacial Europe, and its archeological and chronological context, to clarify to the extent possible the nature of the relationship between hominid groups and the earliest Upper Paleolithic artifact industries, particularly the early Aurignacian. Although substantial difficulties involved in interpreting the fossil, archeological, and geochronological records of this time period prohibit making any definitive statements, a number of observations are suggested by the current data: 1) the Middle Paleolithic of Europe appears to have been made exclusively by Neandertals; 2) Initial Upper Paleolithic industries (with the exception of the Bachokirian) appear to have their roots in the late Middle Paleolithic industries of their respective regions; 3) all of the human fossils yet recovered from Initial Upper Paleolithic (except the Bachokirian) contexts for which any diagnostic morphology is present have their greatest morphological affinities with Neandertals and not early modern humans; 4) modern humans were almost certainly established in Europe by ca. 32 ky BP, with a strong possibility that they were there by ca. 36 ky BP. Claims for an appearance before 36 ky BP cannot be substantiated with currently available evidence; 5) the hypothesis that modern humans are uniquely associated with the Aurignacian cannot yet be refuted. Aurignacian-associated human fossils (including those from the Bachokirian) for which any diagnostic morphology is present have their greatest affinities with early modern Europeans and not Neandertals; and 6) Neandertals and modern humans coexisted in Europe for at least 2,000–4,000 years, and perhaps for 8,000–10,000 years or longer. The overall picture is one of an extended period of cultural contact, involving some degree of genetic exchange, between Neandertals and early modern Europeans. *Yrbk Phys Anthropol* 43:61–115, 2000.

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At the end of the Mousterian phase of paleolithic culture, the Neandertal inhabitants of Europe were abruptly replaced by people of the completely modern human type. There is reason to suppose that this new population, the Aurignacians, having developed their distinctive culture elsewhere, probably in Asia, migrated into Europe and, with their superior social organization, quickly displaced Mousterian man and occupied his territory. (Le Gros Clark, 1966, p. 116–117.)

INTRODUCTION

The latter part of the Interpleniglacial, marked by the approximately 10,000-year-long Hengelo/Denekamp temperate period between 39–29 ky BP, was a dynamic time in European prehistory. It was during this relatively warm and wet interval of oxygen isotope stage 3, in which sediments in caves and rock shelters were as often washing

away as accumulating (Cabrera Valdés and Bischoff, 1989), that the Mousterian culture and Neandertals disappeared, Initial Upper Paleolithic (IUP) cultures proliferated and then disappeared, and the Aurignacian and early modern humans became established across Europe. There continue to be many uncertainties surrounding the emergence of the Upper Paleolithic, particularly the Aurignacian, and early modern humans in Europe. Regardless, accumulating evidence points to marked complexity in the biocultural dynamics of this period, which renders the rather simple perspective on these phenomena reflected in the quotation above increasingly less robust an explanation.

The complexity of the biological and cultural processes associated with the emergence of the Upper Paleolithic and modern humans in Europe is well illustrated by two important discoveries in the last year of the 20th century. First, the direct dating of Neandertal fossils, found in association with Aurignacian-like tools at Vindija Cave (Croatia), to ca. 28–29 ky BP (Smith et al., 1999), has revealed a new intricacy to the pattern of Neandertal extinction, showing as it did that populations of these hominids survived in Central Europe (as well as in the Iberian peninsula and, less certainly, in the Caucasus Mountains) long after the appearance of modern humans on the continent.¹ The meaning and reliability of the stratigraphic association of these late Neandertals with Aurignacian-like tools is not entirely certain (see Zilhão and d'Errico, 1999), but this possible association does call into question the widespread assumption of an Aurignacian-modern human correlation, and also raises doubts about the sagacity of assuming that the contemporaneity of the Châtelperronian and Aurignacian in Western Europe demonstrates coexistence of Neandertals and early modern humans in the time range of 40–28 ky BP. Second, the discovery of a Gravettian-aged juvenile skeleton from Lagar Velho (Portugal) (Duarte et al., 1999) has added fuel to the already heated debate about the extent of the genetic contribution Neandertals made to modern populations. This child has been argued to evince a mosaic of Neandertal and early modern human traits—traits that have been interpreted as demonstrating substantial genetic input from Neandertals to the early modern European gene pool (Duarte et al., 1999). This interpretation stands in contradistinction to results of re-

cent mitochondrial DNA analyses, first on genetic material from the Feldhofer Neandertal (Krings et al., 1997, 1999), and then on a Mousterian-associated infant from Mezmaiskaya Cave (Ovchinnikov et al., 2000), suggesting little if any genetic contribution from Neandertals to the modern European gene pool. Neither of these claims has gone unchallenged (see Tattersall and Schwartz, 1999 on Lagar Velho, and Nordburg, 1998 on the mtDNA results), and the percentage of Neandertal genes in modern Europeans remains a matter of debate. If the morphology of the Lagar Velho child does reflect a degree of Neandertal ancestry, it invokes an image of significant exchange of material culture and mates between neighboring populations of humans.²

A number of other developments in recent years add to the picture of complexity during late Interpleniglacial Europe. These include, but are not limited to: the discovery of Neandertals associated with Initial Upper Paleolithic assemblages at La Roche à Pierrot (St. Césaire: Lévêque and Vandermeersch, 1980) and the Grotte du Renne (Arcy-sur-Cure: Hublin et al., 1996) (the latter case including objects of personal adornment), the radiocarbon dating of the basal Aurignacian to ca. 38.5 ky BP in northern Spain (Bischoff et al., 1989, 1994; Cabrera Valdés and Bischoff, 1989), and the discovery of Neandertals and Mousterian technology with dates showing they persisted in the refugia of southern and western Iberia until as recently as perhaps 28 ky BP (Vega Toscano, 1990; Straus et al., 1993; Hublin et al., 1995), and possibly in the northern Caucasus until about the same time (Golovanova et al., 1999; Ovchinnikov et al.,

¹The dating of the Vindija G₁ hominids was done concurrently with the direct dating of the important hominid frontal bone from Velika Pećina. Originally thought to represent one of the earliest modern humans in Europe based on its association with an Aurignacian component dated to greater than 34 ky BP (Smith, 1976; 1982), Velika Pećina now appears to represent a middle Holocene specimen that was intrusive into the Aurignacian layer (Smith et al., 1999). Thus while the direct dating of the late surviving Vindija hominids suggests a long period of temporal overlap of Neandertals and early modern humans, the dating of the Velika Pećina frontal removes from consideration one of the formerly strongest lines of evidence for an early occupation of Europe by modern humans.

²But populations of what? Opinions differ about the taxonomic level at which Neandertals and modern humans are distinguished, i.e., whether the two groups should be seen as conspecifics (distinguished as subspecies) or as separate species. Since the application of a strict biological species distinction is both premature given the current state of evidence, and presumes that which we seek to know (specifically, the degree of interbreeding), we feel the only defensible approaches are to 1) employ an evolutionary species concept that sees the two groups as sister species that potentially interbred along hybrid zones, or 2) to consider them as subspecies. This question revolves around issues of taxonomy and systematics that are beyond the scope of this review. Therefore, we choose here to simply refer throughout the paper to Neandertals as “Neandertals” and early modern Europeans as “modern humans,” “early modern humans,” “anatomically modern humans,” or early modern Europeans.

2000). All of these developments suggest the Middle-to-Upper Paleolithic "transition" was a multifaceted, regionally variable phenomenon. Out of this realization, five inter-related questions have emerged that are driving much of the research and debate about the biocultural dynamics of this period. These questions, or sets of questions, are:

- 1) Whence the Aurignacian? Did it arise directly from some regional variant of the Mousterian (e.g., as Cabrera Valdés et al., 1997 have suggested for the early Aurignacian of Cantabria), or perhaps from some regionally distinct IUP culture (such as the "Aurignacoid" Bachokirian: see Kozłowski et al., 1982)? If so, why did the bone and lithic artifact types of the Aurignacian appear so rapidly and so widely across Europe (Harrold, 2000)? Or was the origin of the Aurignacian exogenous to Europe, occurring perhaps in the Near East and arriving in Europe in the hands of immigrating populations (Mellars, 1996)? If the latter, the source area has yet to be discovered (despite the fact that Levantine assemblages that could be characterized as Upper Paleolithic could date to as old as 50 ky BP (see Mellars, 1996), specific Near Eastern analogs of the Aurignacian emerge only *after* the appearance of the Aurignacian in Europe; Marks, 1993). The center of origins of the Aurignacian remains elusive, and this raises uncertainty over whether the birth of the Aurignacian was a single, regionally circumscribed event, or the end product of a pan-European trend in technology (favoring blade production) that resulted in the convergent development of the Aurignacian or Aurignacian-like industries in different regions (Oliva, 1993; Cabrera Valdés and Bernaldo de Quiros, 1996; Straus, 1997; Karavanić and Smith, 1998). This latter perspective raises the question whether the Aurignacian was a single ethnic or cultural entity, either across space or through time (see Mellars, 1996; Miracle, 1998).
- 2) How were hominid taxa and lithic cultures related? The well-documented as-

sociation of modern humans with Mousterian artifacts in the Near East and North Africa (McCown and Keith, 1939; Vandermeersch, 1981; Vermeersch et al., 1998), combined with the clear association of Neandertals with IUP (e.g., at St. Césaire and Arcy-sur-Cure: Lévêque and Vandermeersch, 1980; Hublin et al., 1996) and Aurignacian-like (at Vindija: Karavanić, 1995; Karavanić and Smith, 1998) assemblages in Europe, calls into question any generalizations about which hominids were making which industries. This question is critical, however, to our understanding of the dynamics of the emergence of the Upper Paleolithic in Europe, since it lies at the base of our models of the interaction between Neandertals and early modern humans. As pointed out by Harrold (1989, 2000), Straus (1997), and others, the possibility that the European Mousterian was, until its very end, the product of Neandertal cultural behavior, and that the Upper Paleolithic, at least from Aurignacian times onward, was made by anatomically modern humans, raises the additional possibility that the cultural transition from Middle-to-Upper Paleolithic reflects differences in the cultural capacities of these two types of hominid.

- 3) What were the biological and cultural processes that led to the emergence and spread of the Upper Paleolithic, as seen in both the regional florescence of IUP industries and in the emergence of a pan-European Aurignacian? Do regionally distinct IUP industries represent autochthonous development from local Mousterian antecedents (e.g., d'Errico et al., 1998; Zilhão and d'Errico, 1999), or acculturated derivations of the Mousterian, possibly having come about through cultural diffusion from contact with Aurignacian-bearing peoples (see Harrold, 1989; Mellars, 1996)?
- 4) What was the timing of the disappearance of Neandertals and the appearance of modern humans in different regions (and vis-à-vis the questions above, how is this related to the appearance of the Upper Paleolithic and the disappearance of

the Middle Paleolithic in different regions)? Recent dating of late Mousterian (Vega Toscano, 1990; Straus et al., 1993) and Neandertal (Hublin et al., 1995; Smith et al., 1999; Ovchinnikov et al., 2000) remains suggests a considerable time of Neandertal/modern human co-occupation of Europe, spanning perhaps 10,000 years. Confirming this possibility is made difficult, however, by uncertainties in radiometric dating (see Mellars, 1999 vs. Zilhão and d'Errico, 1999) and by a paucity of diagnostic human remains in good association with early Upper Paleolithic assemblages in Europe.

- 5) What were the adaptive and behavioral characteristics of late Neandertals and early modern Europeans, and what was the nature of the interaction between them? Do typological and technological differences between artifact assemblages reflect important differences in adaptive modalities, and might these differences then provide insight into the biocultural dynamics surrounding the development of the Upper Paleolithic and the demise of the Neandertals? Furthermore, what was the nature of settlement patterning and niche partitioning that could allow two adaptively similar groups of humans to coexist in Europe for thousands of years (Mellars, 1998)?

The answers to these questions are inextricably and frustratingly bound up in one another, making the resolution of any particular question difficult. Added to this difficulty are ambiguities in the fossil, archeological, and geochronological records that have contributed additional subjectivity to the interpretation of the prehistory of Interpleniglacial Europe. In this paper we review early (pre-30 ky BP) Aurignacian, as well as Initial Upper Paleolithic, sites that have produced human remains, and we review the evidence pertaining to the taxonomic diagnosis of those remains, to clarify the current state of knowledge concerning hominid-cultural associations. We do so because implicit in much of the discussion of the dynamics of modern human origins in this region is the assumption that Neandertals produced the Middle Paleolithic and Initial

Upper Paleolithic industries, and that anatomically modern humans produced the Aurignacian and subsequent Upper Paleolithic industries (see Stringer et al., 1984; Gambier, 1989; Stringer, 1992; Hahn, 1993; d'Errico et al., 1998; Miracle, 1998).

INTERPLENIGLACIAL CHRONOLOGY AND ENVIRONMENTS

An understanding of the biocultural dynamics of the Middle-to-Upper Paleolithic transition requires a firm geochronological framework, yet difficulties with the reliability and interpretation of various dating methods add still more ambiguity to that already surrounding the classification of scrappy, undiagnostic fossils and small, typologically mixed artifact assemblages (see Zilhão and d'Errico, 1999). Radiocarbon dating continues to play the dominant role in dating the emergence of the Upper Paleolithic and the advent of modern humans. The development of accelerator mass spectrometry (AMS) in the late 1970s greatly improved the utility of ^{14}C dating (by allowing use of smaller samples, thereby minimizing the effects of contamination, and by extending the datable range of organic material an additional 10,000 years),³ but accelerator dating still suffers the same problems of contamination and calibration as its older sibling, conventional radiocarbon (Gowlett, 1987). Because atmospheric levels of ^{14}C vary in response to fluctuations in geomagnetic fields, solar activity, and the earth's surficial geochemistry, radiocarbon years do not directly correspond to calendar years (Kitagawa and van der Plicht, 1998). Only the recent end of the radiocarbon scale (back to ca. 13 ky BP) has been calibrated by dendrochronology and data from glacial varves (references in Kitagawa and van der Plicht, 1998). Recent work comparing U-series and ^{14}C dates in corals (Bard et al., 1990) and speleothems (Vogel and Kronfeld, 1997), and dating macrofossils in lake sedimentation varves (Kitagawa and van der

³AMS relies on direct spectrometric counting of ^{14}C atoms, whereas conventional radiocarbon measures radioactive decay rates to estimate ^{14}C content. AMS can therefore detect a smaller ^{14}C fraction, allowing for an extension of the datable range of radiocarbon time.

TABLE 1. Representative absolute dates for the final Mousterian, earliest Initial Upper Paleolithic, and earliest Aurignacian for various regions in Europe¹

Site/layer	Method	Date	Source
Eastern Europe			
<i>Final Mousterian</i>			
Akhstyr (Russia)	U-Th	35.0 ± 2.0	Lioubine, 1993
Betovo (Russia)	¹⁴ C	36.5 ± 0.1	Soffer, 1989
Mezmaiskaya (Russia)	AMS	29.2 ± 1.0	Ovchinnikov et al., 2000
		40.7 ± 1.6	
		>45.0	
Malaia Voronçov	¹⁴ C	35.7 ± 0.5	Lioubine, 1993
Molodova V (Russia)/ashy band	¹⁴ C	>35.6	Soffer, 1989
<i>Streletskaia</i>			
Kostenki 12 (Russia)/1a	¹⁴ C	32.7 ± 0.7	Soffer, 1989
<i>Spitsynskaya</i>			
Kostenki 17 (Russia)/2	¹⁴ C	32.2 + 2.0–1.6	Soffer, 1989
		32.8 ± 0.3	
		36.4 + 1.7–1.4	
Central Europe			
<i>Final Mousterian</i>			
Crvena Stijera (Croatia?)/12	¹⁴ C	40.8 ± 0.9	Vogel and Waterbolk, 1972
Erd (Hungary)/d	¹⁴ C	35.3 ± 0.9	Vogel and Waterbolk, 1972
		39.4 ± 0.8	
Gura Cheii (Romania)	¹⁴ C	29.7 + 1.7–1.4	Cârciumaru, 1989
Ohaba Ponor (Romania)/IIIa	¹⁴ C	39.2 + 4.5–2.9	Allsworth-Jones, 1990a
		>41.0	
Pestera Cioarei (Romania)/II (top)	¹⁴ C	37.8 ± 1.0	Allsworth-Jones, 1990a
Ripiceni-Izvor (Romania)/IV–V	¹⁴ C	40.2 + 1.1–1.0	Allsworth-Jones, 1990a
Tata (Hungary)	¹⁴ C	33.3 ± 0.9	Vogel and Waterbolk, 1972
Tokod (Hungary)	¹⁴ C	36.2	Gábori-Csánk, 1970
<i>Bachokirian</i>			
Bacho Kiro (Bulgaria)/11	¹⁴ C	>43.0	Mook, 1982
	AMS	33.8 ± 0.9	Hedges et al., 1994
		34.8 ± 1.2	
		37.7 ± 1.5	
		38.5 ± 1.7	
Istállosko (Hungary)/lower	¹⁴ C	39.7 ± 0.9	Vogel and Waterbolk, 1972
		44.3 ± 1.9	
Temnata (Bulgaria)/4b	AMS	36.9 ± 1.3	Ginter et al., 1996
		38.2 ± 1.5	
		38.3 ± 1.8	
		38.8 ± 1.7	
		39.1 ± 1.8	
	TL	45 ± 7	Ginter et al., 1996
		46 ± 8	
<i>Szeletian</i>			
Bohunice (Czech Republic)	¹⁴ C	40.2 ± 1.2	Svoboda, 1990
		41.4 + 1.4–1.2	
		42.9 + 1.7–1.4	
Stránska Skála (Czech Republic)/IIIa	¹⁴ C	41.3 + 3.1–2.2	Svoboda, 1990
Szeleta (Hungary)/C3	¹⁴ C	43.0 ± 1.1	Allsworth-Jones, 1990b
<i>Aurignacian</i>			
Krems-Hundssteig (Austria)	¹⁴ C	35.2 ± 2.0	Allsworth-Jones, 1990b
Mitoc Malu Galben (Romania)/III	¹⁴ C	31.9 ± 0.8	Allsworth-Jones, 1990a
Pesko (Hungary)	¹⁴ C	34.6 ± 0.6	Allsworth-Jones, 1990b
		35.2 ± 0.7	Vogel and Waterbolk, 1972
Samuilica Cave (Bulgaria)	¹⁴ C	42.8 ± 1.3	Vogel and Waterbolk, 1972
Willendorf C (Austria)/+	¹⁴ C	41.7 + 3.7	Allsworth-Jones, 1990b
Willendorf C (Austria)/2	¹⁴ C	39.5 + 1.5–1.2	Allsworth-Jones, 1990b
Northwestern Europe			
<i>Final Mousterian</i>			
Coygan Cave (Great Britain)	¹⁴ C	38.7 + 2.7–2.0	Aldhouse-Green and Pettitt, 1998
Creswell Crags (Great Britain)	¹⁴ C	37.2 ± 1.3	Aldhouse-Green and Pettitt, 1998
		>42.7 ± 1.6	
Hyaena Den (Great Britain)	¹⁴ C	34.9 ± 1.5	Aldhouse-Green and Pettitt, 1998
		40.4 ± 1.6	
Scladina (Belgium)/1A	¹⁴ C	38.7 ± 1.5	Bastin et al., 1986
<i>Leaf-point early Upper Paleolithic</i>			
Bench Tunnel Cavern (Great Britain)	¹⁴ C	27.2–34.5	Hedges et al., 1989
Couvin (Belgium)	¹⁴ C	~45.0	Otte, 1990
(?) Picken's Hole (Great Britain)	¹⁴ C	27.5 ± 2.6	ApSimon, 1986
		34.4 + 2.6–1.9	

(Continued)

TABLE 1. (Continued)

Site/layer	Method	Date	Source
<i>Aurignacian</i>			
Geißenklösterle (Germany)/IIa	AMS	33.2 ± 0.5 33.7 ± 1.1 36.8 ± 1.0	Hahn, 1995, 1996
Geißenklösterle (Germany)/IIIa	AMS	33.1 ± 0.7 33.5 ± 0.6 37.8 ± 1.1 40.2 ± 1.6	Hahn, 1996 Zilhão and d'Errico, 1999
Trou Magrite (Belgium)/3	TL	40.2 ± 1.5	
Vogelherd (Germany)/V	AMS	41.0 ± 1.7	Otte and Straus, 1995
	¹⁴ C	31.9 ± 1.1 30.2 ± 1.3	Müller-Beck, 1983
Italian Peninsula			
<i>Final Mousterian</i>			
Buca del Iena (Italy)	U-Th	<40.0	Pitti and Tozzi, 1971
Grotta Breuil (Italy)/3	ESR	36.6 ± 2.7	Schwarz et al., 1991
<i>Uluzzian</i>			
Cavallo (Italy)/EII-I	¹⁴ C	>31.0	Bietti, 1997
Grotta di Castelcivita (Italy)/rpi	¹⁴ C	33.0-32.0	Bietti, 1997
<i>Aurignacian</i>			
Grotta di Fumane (Italy)/A2	AMS	31.6 ± 0.4 36.8 + 1.2-1.4	Bietti, 1997
Grotta di Paina (Italy)	AMS	37.9 ± 0.8 38.6 + 1.4-1.8	Bietti, 1997
France and Northeastern Spain			
<i>Final Mousterian</i>			
L'Arbreda (Spain)/B1	AMS	34.1 ± 0.8 39.4 ± 1.4 41.4 ± 1.6	Bischoff et al., 1989
Camiac (France)	¹⁴ C	35.1 + 2.0-1.5	Delibrias and Evin, 1980
Les Cottés I (France)	¹⁴ C	37.6 ± 0.7	Vogel and Waterbolk, 1967
Cueva Millán (Spain)/Ia	¹⁴ C	37.6 ± 0.7	Moure Romanillo and Garcia Soto, 1983
Els Ermitons (Spain)	¹⁴ C	36.4 ± 1.8	Harrold, 1989
La Quina (France)	¹⁴ C	35.3 ± 0.5 34.1 ± 0.7	Vogel and Waterbolk, 1967
Arcy (France)/XII	¹⁴ C	34.6 ± 0.9	Vogel and Waterbolk, 1967
La Rochette (France)/7	¹⁴ C	36.0 ± 0.5	Vogel and Waterbolk, 1967
Romaní (Spain)	U-series	39-43	Harrold, 1989
<i>Châtelperronian</i>			
Le Moustier (France)/K	TL	42.6 ± 3.2	Valladas et al., 1986
St. Césaire (France)/EJOP Sup (8)	TL	36.3 ± 2.7	Mercier et al., 1991
Arcy (France)/X	AMS	33.8 ± 0.7	Zilhão and d'Errico, 1999
Arcy (France)/IX	AMS	45.1 ± 2.8	Zilhão and d'Errico, 1999
Combe Saunière (France)/X	AMS	33.0 ± 0.9 38.1 ± 1.0	Zilhão and d'Errico, 1999
Grotte XVI (France)/B	AMS	35.0 ± 1.2 38.1 ± 1.7 >39.8	Zilhão and d'Errico, 1999
Roc de Combe (France)/X	AMS	31.0 ± 0.8 38.0 ± 2.0	Zilhão and d'Errico, 1999
<i>Aurignacian</i>			
Caminade (France)/G	AMS	37.2 ± 1.5	Zilhão and d'Errico, 1999
Caminade (France)/F	AMS	35.4 ± 1.1	Zilhão and d'Errico, 1999
Castanet (France)/Inférieur	AMS	35.2 ± 1.1	Zilhão and d'Errico, 1999
Castillo (Spain)/18c	AMS	39.8 ± 1.4 40.0 ± 2.1 40.7 ± 1.5 41.1 ± 1.7 42.2 ± 2.1	Cabrera Valdés and Bischoff, 1989; Cabrera Valdés and Bernaldo de Quiros, 1996
Castillo (Spain)/18b2	AMS	37.1 ± 2.2 37.7 ± 1.8 38.5 ± 1.3 40.7 ± 1.6	Cabrera Valdés and Bischoff, 1989; Cabrera Valdés and Bernaldo de Quiros, 1996
Castillo (Spain)/18b1	AMS	38.5 ± 1.8	Cabrera Valdés and Bischoff, 1989
Combe Saunière (France)/VII	AMS	34.0 ± 0.9	Zilhão and d'Errico, 1999
Isturitz (France)/U27 4d	AMS	36.5 ± 0.6	Zilhão and d'Errico, 1999
Isturitz (France)/V1 26	AMS	34.6 ± 0.6	Zilhão and d'Errico, 1999

(Continued)

TABLE 1. (Continued)

Site/layer	Method	Date	Source
L'Arbreda (Spain)/B1	AMS	37.7 ± 1.0 37.7 ± 1.0 38.7 ± 1.2 39.9 ± 1.3	Bischoff et al., 1989
Reclau Viver (Spain)/TIII-27	AMS	40.0 ± 1.4	Straus, 1997
Romani (Spain)/2	AMS	37.1 ± 1.0	Bischoff et al., 1994
	U-series	>42.6 ± 1.1	Bischoff et al., 1994
Portugal/southern Iberia			
<i>Final Mousterian</i>			
Columbeira	¹⁴ C	28.9 ± 1.0	Antunes et al., 1989
Figueira Brava	¹⁴ C/U-series	31–30	Antunes, 1990
Gruta do Caldeirao	AMS	27.6 ± 0.6	Zilhão, 1993
Pedreira das Salemas	¹⁴ C	29.9 ± 1.0	Antunes et al., 1989
Zafarraya	AMS/U-series	32–29	Hublin et al., 1995
<i>Aurignacian</i>			
Gato Preto (Portugal)	TL	38.1 ± 3.9	Marks et al., 1994
La Viña (Spain)/XIII inf	¹⁴ C	36.5 ± 0.8	Zilhão and d'Errico, 1999

¹ All dates in ky BP.

Plicht, 1998), are for the first time allowing preliminary extension of the calibrated ¹⁴C range back to about 38 ky BP. While much remains to be resolved (see van Andel, 1998; van der Plicht, 1999), these studies show that in the time range from 30–40 ky BP (the practical end of the ¹⁴C range), ¹⁴C consistently (*but not uniformly*) produces dates 2,000–4,000 years too recent. Other dating methods applicable to the later Pleistocene—thermoluminescence (TL), electron spin resonance (ESR), and uranium series (U-series)—are independent of the earth's ¹⁴C history, and thus are expected to produce dates more concordant with calendar time. Some prehistorians recommend “correcting” TL, ESR, and U-series dates by subtraction of age-specific constants to convert them to radiocarbon years (see Zilhão and d'Errico, 1999), but uncertainties in the form of the calibration curve (see van der Plicht, 1999) render the use of such corrections premature. All dates discussed in this paper are in radiocarbon years unless otherwise indicated.

Given that dating the events of the Interpleniglacial requires operating at the practical limits of radiocarbon, and given unevenness in the radiocarbon calibration curves, reported ¹⁴C determinations should be treated with caution. While we can generally assume that radiocarbon dates provide a reasonably accurate probable mean age of deposition within a known error

range, it is important to bear in mind that the older the sample, the greater the possibility and the impact of contamination, and that radiocarbon produces dates on a different scale than other methods, and thus care must be taken in the interpretation of dating results (see Zilhão and d'Errico, 1999).

Paleoenvironmental indicators within an archeological horizon provide additional information that may help to place a site in time. Consideration of the overall pattern of radiocarbon dates across Europe (Table 1) suggests that both IUP and Aurignacian cultures arose around the time of the Würm II/III interstadial (the Hengelo or Podrahem temperate period: Fig. 1), during the interval between ca. 39–37 ky BP. Kozłowski (1996) notes that, given the underestimation bias of radiocarbon dating, horizons dated to the Hengelo may actually have been deposited during the preceding Moershoofd temperate period (between ca. 45–50 ky BP). Discrepancies between radiocarbon dates from land and marine cores have been noted (Rossignol-Strick, 1995), making correlation of the climatic and chronological records difficult. However, since ¹⁴C dates from pollen sequences (e.g., Shotton, 1977) are subject to the same calibration error as all ¹⁴C dates, the pollen zone chronology (as in Fig. 1) should generally correspond to radiocarbon years.

The Interpleniglacial (or Middle Würm), even during full stadial episodes, was

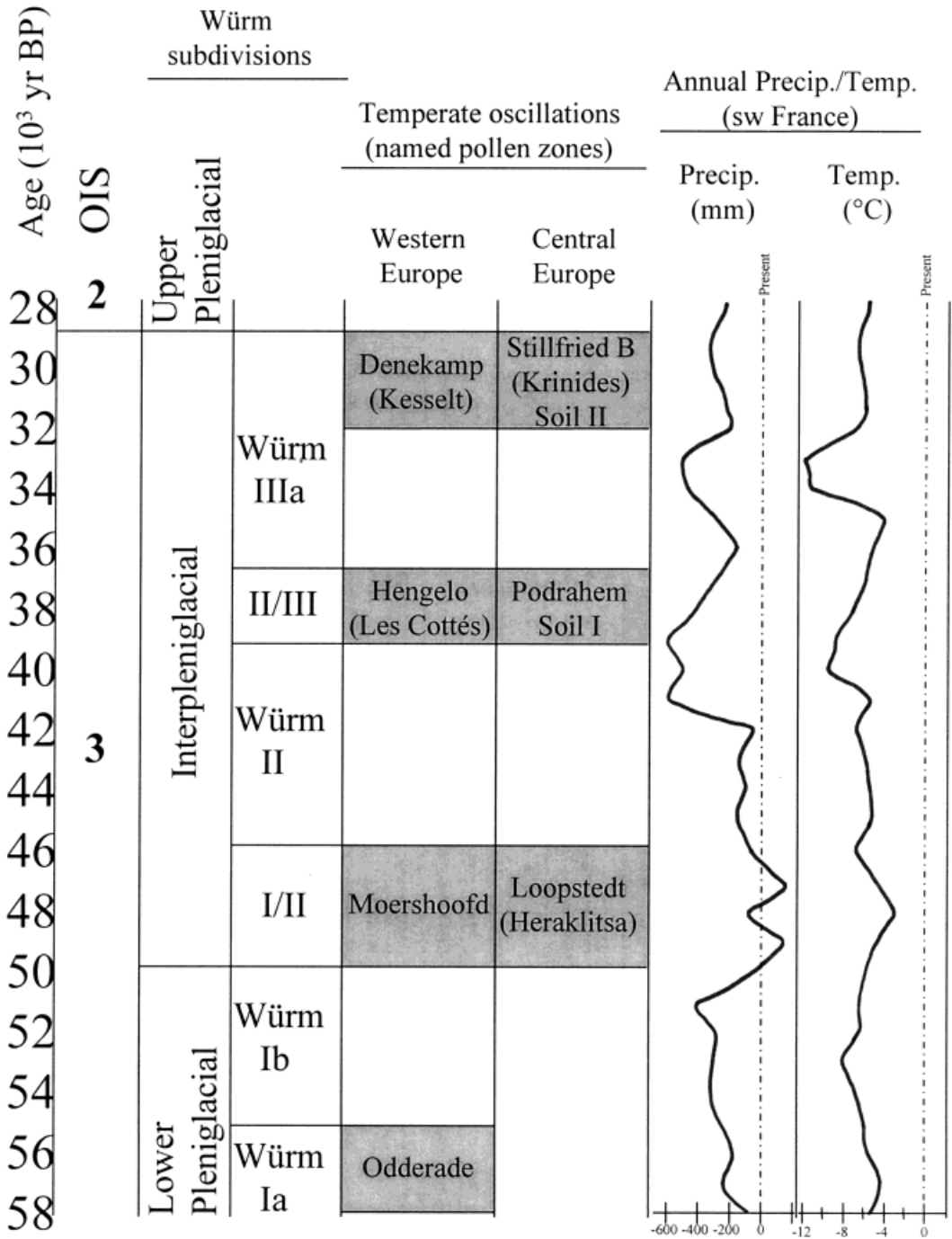


Fig. 1. Approximate correlations between interstadial and glacial stadal periods in Central and Western Europe during the early and mid-Würm. (Würm subdivisions are based on Alpine river terrace deposits. The Würm glacial is also known as the Weichsel in Northern Europe and the Devensian in the British Isles.) Ages of interstadials are based on ¹⁴C determinations from Northern European pollen sequences (largely but not exactly following Shotton, 1977) and should be taken as

approximate. Precipitation and temperature curves from regional pollen sequences vary in the timing of the onset and end of temperate periods, making correlations across regions difficult. The rainfall and temperature curves depicted here are derived from the pollen sequence at Les Eschets, southwestern France (data from Guiot et al., 1989). The present-day base (dashed) line represents rainfall of 800 mm and mean annual temperature of 11°C.

milder in climate than the glacial cycles before and after (the Lower and Upper Pleniglacial periods, respectively). Climatic fluctuations during this period were generally mild but frequent, due to intermittent activation of the north Atlantic thermohaline circulation (see van Andel and Tzedakis, 1996a). Although mild, fluctuations were likely rapid, occurring in some cases on the order of a few decades or less (as reflected in oxygen isotope ratios in the Greenland Summit ice core: Dansgaard et al., 1993). In addition, the Interpleniglacial was punctuated by three major temperate oscillations. The first of these was the Moershoofd (in the northwestern European pollen scheme, or the Loopstedt or Heraklitsa in the central European scheme), between ca. 50–43 ky BP (date based on Shotton, 1977). As reflected in the pollen sequences from France (Les Echets and La Grande Pile), the Moershoofd saw rainfall in excess of modern precipitations (by as much as 100 mm) but mean annual temperatures about 4°C below modern norms (Guiot et al., 1989). During the subsequent stadials of Würm II, IIIa, and IIIb, mean annual temperatures may have been 10°C or more below modern European values, with precipitation half or less of that received by Europe today (Guiot et al., 1989). The stadials saw the spread of steppe grasslands in Southern Europe (with the retention of wooded refugia in sheltered valley systems), arctic steppe and tundra above 45° N latitude, and possible ice advances in Northern Europe (van Andel and Tzedakis, 1996a). Perhaps the most severe of these occurred during Würm IIIa, with mean annual temperatures about 12°C below modern norms (Guiot et al., 1989), and with winter temperatures of –20°C not unusual (Mellars, 1998). Even in the south of Europe, faunal assemblages dated to this interval are heavily dominated by reindeer, while those of the interstadials are typically representative of a more temperate woodland fauna (red deer, horse, aurochs, bison: references in Mellars, 1998).

The second temperate oscillation of the Interpleniglacial was the Hengelo interstadial (the Würm II/III interstadial, also known as Les Cottés in Western Europe, or Podrahem or Kalabaki in Central Europe),

between ca. 40–37 ky BP. Interstadial conditions fostered soil formation in Central and Northwest European loess deposits, and thus the interstadials are commonly referred to stratigraphically identified soils. The Hengelo has thus variously been called “Soil I” or “Les Vaux soil” in loess regions (e.g., Svoboda, 1988). The final interstadial of the Interpleniglacial occurred roughly between 32–29 ky BP, and is known in Western European schemes as the Denekamp, Arcy, Kesselt, or Les Eyzies (although some consider the Arcy to be a separate, short-lived, and earlier temperate oscillation), and in Central Europe as the Krinides, Stillfried B, or Soil II period. Despite the more temperate conditions, during Hengelo and Denekamp times temperatures were 4–5°C colder than today, and precipitation was roughly 20–25% below modern European values (Guiot et al., 1989). During the warmer interstadials, much of Europe was covered with open (almost parkland) mixed pine and deciduous forest, with decreasing abundance of hardwoods moving north (van Andel and Tzedakis, 1996a). Between 45°–55° N latitude, much of Europe was characterized by evergreen woodlands (open coniferous forest), while above 55° N, shrub tundra dominated (van Andel and Tzedakis, 1996b).

Although it seems certain that climatic instability played a role in the biocultural transitions of the Interpleniglacial, what that role might have been is unclear. It has long been recognized that the stadial cycles of the Ice Age had important consequences for human settlement and demography in Europe (e.g., Gamble, 1986; Roebroeks et al., 1992; van Andel, 1998; Mellars, 1998), following a general (although not rigid: see Roebroeks et al., 1992) pattern of northerly population advances during temperate intervals and southerly retreats when the climate deteriorated. Recently, Mellars (1998) proposed that the warmer and wetter conditions of the interstadials, especially that of the Hengelo temperate oscillation, may have allowed the initial colonization of Europe by anatomically modern humans despite the presence of resident populations of Neandertals. The warmer periods may have done so by both expanding the range of tem-

perate environments in Southern Europe to which modern humans (presumably occupying portions of the Levant and northern Africa) were already well adapted, and also by disrupting the distribution of indigenous Neandertal populations, thus creating vacant zones into which modern humans could expand without facing demographic competition (Mellars, 1998; Hoffecker, 1999). The subsequent cold interval of Würm IIIa may have stressed the adaptive capacities of both groups (as modern humans faced the new adaptive challenges of stadial Europe, and Neandertals faced stadial conditions in the context of new competitive pressures from modern populations), and may have been an important factor in the demise of the Neandertals (Mellars, 1998). The temporal patterning of IUP and Aurignacian sites in southwestern Europe broadly supports this model (Mellars, 1998), but only if one makes the usual assumptions about hominid-cultural associations (i.e., Middle and Initial Upper Paleolithic assemblages equate with Neandertals, Aurignacian and later Upper Paleolithic assemblages equate with modern humans).

The warmer and wetter environments during the above-named temperate oscillations appear to have accelerated erosion of sediments in caves and rockshelters. For example, at the abri La Roche à Pierrot (St. Césaire), a 2,000-year hiatus separates the uppermost Mousterian from the lowermost Châtelperronian (Mercier and Valladas, 1996). Cabrera-Valdés and Bischoff (1989) contend that a depositional hiatus beginning 40–37 ky BP and ending perhaps around 34 ky BP (thus likely corresponding to the Hengelo temperate oscillation) has removed critical early Upper Paleolithic levels from many Western European sites. The resulting Mousterian/Aurignacian discontinuity may then lend a false appearance of an abrupt cultural replacement. While the role these temperate oscillations played in the human biocultural transition is not entirely certain, the increased erosion rates that they brought have no doubt contributed to the scarcity of diagnostic human and earliest Upper Paleolithic artifactual remains from this time period.

THE END OF THE MOUSTERIAN IN EUROPE

Terminal dates for the Mousterian are uncertain, and no clear geographic pattern to its disappearance has yet been established (Table 1). Until recently, the youngest dates reported from Russia suggested a Mousterian terminus there at around 36.5 ky BP (Soffer, 1989), although a few younger dates have been reported (e.g., a U-Thorium date of 35.0 ± 2.0 ky BP on level 3 at Akhstyr Cave, and a ^{14}C determination of 35.7 ± 0.5 ky BP from level 3 of Malaïa Voronçov: Lioubine, 1993). The bulk of dates on Russian Early Upper Paleolithic assemblages tend to fall around 33–32 ky BP (Soffer, 1989), which may indicate a depositional hiatus that has obscured either the end of the Mousterian or the beginning of the Upper Paleolithic. However, recent accelerator mass spectrometric (AMS) dating of presumably Neandertal subadult remains, associated with Mousterian tools at Mezmaiskaya cave in the northern Caucasus, indicates an age of 29.2 ± 1.0 ky BP (Ovchinnikov et al., 2000). Similar dates (ca. 30 ky BP) have been reported for late Middle Paleolithic assemblages in Crimea (Chabai and Marks, 1998). This suggests a later terminus for the Mousterian, as well as a 3,000–4,000-year temporal overlap of Mousterian and early Upper Paleolithic in Eastern Europe. However, previous ^{14}C determinations from the Mousterian level at Mezmaiskaya indicate ages of 45.0 and 40.7 ± 1.6 ky BP (Golovanova et al., 1999), raising questions about the true age of the Mousterian at the site, and highlighting the need for further dating of the terminal Middle Paleolithic in Eastern Europe.

Dates for final Mousterian layers at Central European sites tend to fall between 36–41 ky BP, with most of them clustering around 40–39 ky BP. However, younger dates have been reported from two Hungarian sites (Érd layer d and Tata; 35.3 ± 0.9 and 33.3 ± 0.9 ky BP, respectively: Vogel and Waterbolk, 1972) and from the Romanian site of Gura Cheii Cave (29.7 ± 1.7 ky BP: Cârciumar, 1989). In France and northeastern Spain there are a number of radiocarbon determinations that indicate

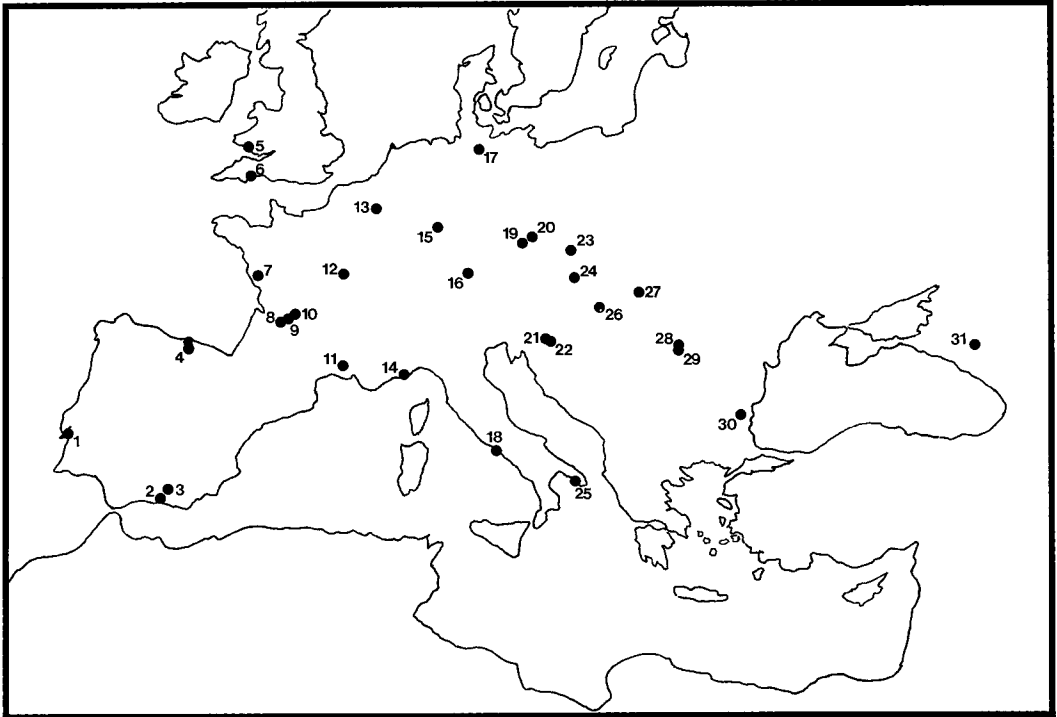


Fig. 2. Locations of sites discussed in the text: 1, Figueira Brava (Portugal); 2, Zafarraya (Spain), Carigüela (Spain); 4, El Castillo and Camargo (Spain); 5, Paviland (England); 6, Kent's Cavern (England); 7, St. Césaire (France); 8, Combe Capelle and La Ferrassie (France); 9, Le Moustier and Font de Gaume (France); 10, Cro-Magnon (France); 11, Hortus (France); 12, Arcy-sur-Cure (France); 13, Couvin (Belgium); 14, Riparo Bombrini (Italy); 15, Kelsterbach (Germany); 16, Vo-

gelherd (Germany); 17, Hahnöfersand (Germany); 18, Fossellone and Grotta Breuil (Italy); 19, Zlatý kůň (Czech Republic); 20, Svatý Prokop and Podbaba (Czech Republic); 21, Veternica (Croatia); 22, Vindija (Croatia); 23, Mladeč (Czech Republic); 24, Dzeravá Skála (Czech Republic); 25, Cavallo (Italy); 26, Mariaremete (Hungary); 27, Istállóskő (Hungary); 28, Cioclovina (Romania); 29, Ohaba Ponor (Romania); 30, Bacho Kiro (Bulgaria); and 31, Mezmaiskaya (Russia).

the Mousterian lasted until as recently as 35–34 ky BP, and it is now well established that the Mousterian persisted until ca. 28 ky BP in Iberia (Table 1).

The makers of the Mousterian

Despite the unquestionable association of early modern humans with Mousterian assemblages in the Levant (McCown and Keith, 1939; Vandermeersch, 1981) and North Africa (Vermeersch et al., 1998), there is as yet no evidence to refute the idea that Neandertals were the sole producers of the Mousterian in Europe. Neandertal remains have been recovered from terminal Mousterian levels on the Iberian Peninsula (at Zafarraya: Hublin et al., 1995; and Carigüela: García Sanchez, 1960; de Lumley and García Sanchez, 1971; and possibly Figueira

Brava: Antunes, 1990), in France (at Le Moustier: Bordes, 1959; Valladas et al., 1986; and Hortus: Piveteau et al., 1963), in Belgium (at Couvin: Ulrix-Closset et al., 1988), in Italy (at Grotta Breuil: Manzi and Passarello, 1995), and in Romania (at Ohaba Ponor: Allsworth-Jones, 1990a) (Fig. 2). Thus far no diagnostic modern human remains have been found in good association with a Mousterian assemblage in Europe. Claims for such associations, however, have been made for Carigüela Cave (Andalusia, Spain), Veternica (Croatia), and Starosel'e (Ukraine). Craniofacial and postcranial remains from the Czech site of Svatý Prokop, possibly associated with Mousterian-like lithic artifacts and fauna suggestive of Würm II, may also fit with this group. Because such associations would have im-

portant implications for our understanding of the biocultural dynamics of this time period, we briefly review the nature of the evidence from each site below.

Carigüela. Excavated initially by J.-C. Spahni in 1954–1955, Carigüela (or Carihuela) has a long Mousterian sequence (possibly extending from Würm IV [OIS 2] to the last or Eem interglacial [OIS 5e]: see Straus et al., 1993), capped by a Neolithic uppermost level (Garralda, 1997). In addition to finding remains attributable to Neandertals in Mousterian levels 6, 7, and 9 (now Units V, VI, and VIII: Vega Toscano et al., 1988), Spahni also found the remains of gracile anatomically modern humans in levels 2 and 3 (García Sanchez, 1960; de Lumley and García Sanchez, 1971). These levels he attributed to a Mousterian with Upper Paleolithic (Aurignacian) influence. The remains include a small parietal fragment (Píñar 4) from strata 2 (now Unit III), a right-side hemimandible with M_{1-3} (Píñar 5) also from level 2 (Unit III), and a partial tibia (Píñar 6) from the top of level 3 (now Unit IVa) (Straus et al., 1993; Garralda, 1997). Restudy of the artifact assemblages and stratigraphy of Carigüela failed to document an Upper Paleolithic component (Almagro et al., 1970; Vega Toscano et al., 1988), and there appears to have been an occupational hiatus at the site between the Middle Paleolithic and the Neolithic. The tools from Spahni's strata 2 and 3 are typologically and technologically Mousterian (with no indication of Upper Paleolithic tool types) that might have been secondarily deposited in levels 2 and 3 as colluvium from the cave mouth (Vega Toscano et al., 1988). The human remains are gracile even by Upper Paleolithic standards, and are similar in morphology, dental pathology, and postmortem modification to Neolithic human remains from Carigüela level 1 and other local sites (García Sanchez, 1960; Garralda, 1997). The association of gracile modern humans and Mousterian lithics in the upper portion of Carigüela Cave is most likely the result of secondary mixing (either colluvial deposition of Mousterian artifacts from the cave mouth onto a Neolithic-aged cave surface, or intrusive Neolithic burial into Mousterian

levels) or poor stratigraphic control on the part of Spahni (see Straus et al., 1993). Until the human remains can be directly dated, the evidence at Carigüela is too tenuous to support a serious claim of a modern human-Mousterian association in Europe.

Veternica. A similar example is provided by the case of Veternica Cave, located just outside Zagreb in Croatia. A long stratigraphic sequence, extending from the Mousterian through the Roman period, was excavated here in the 1950s (Malez, 1956). A fragmentary calvarium (VTR 830/55) was interpreted as deriving from a Riss-Würm Mousterian stratum and was widely cited as evidence of modern humans associated with the Mousterian (e.g., Škerlj, 1958; Coon, 1962). However, the state of preservation and morphology of this specimen conformed exactly to a series of later (mostly Mesolithic) skulls from the site, and the stratigraphic location of the specimen strongly suggests an intrusive burial (Smith, 1977). As with Carigüela, Veternica does not provide a compelling case for modern human-Mousterian association.

Svatý Prokop. An adult occipital fragment and femoral head were recovered from a travertine/loess breccia in a fissure at the base of Svatý Prokop Cave in 1887. The breccia also yielded a questionable bone tool, lithic artifacts with affinities to the Mousterian, and a fauna suggestive of early Interpleniglacial (Würm II) times (Vlček, 1951, 1996). According to Vlček (1951, 1996), the occipital morphology of the Svatý Prokop specimen compares favorably with Zlatý Kůň, suggesting it derives from an early modern human. Bräuer and Broeg (1998) also mention a mandible that presumably belongs to this individual. Still partly encased in matrix, the mandible exhibits a mental eminence and trigone, as well as other features, that align it with modern human mandibular form. Unfortunately, the typological diagnosis of the artifact assemblage is uncertain, and the taphonomy of the breccia formation has not been studied, making the true age of this specimen highly uncertain. If the Würm II attribution from the fauna is correct, this speci-

men would rate as one of the earliest modern humans in Europe, a possibility that should be further explored with direct dating.

Starosel'e. In 1953, A. Formozov excavated a child's skeleton from below a Middle Paleolithic level at the site of Starosel'e (Formozov, 1958). The taxonomic status of the specimen is somewhat uncertain, with many accepting the presence of both Neanderthal and modern human features in the skeleton, and accordingly there has been a diversity of views on the significance of this specimen to modern human origins (see review in Marks et al., 1997). The skeleton, representing a child between the ages of 1.5–3 years at death, exhibits the modern traits of a high frontal angle, pronounced chin, and marked canine fossa, but appears more primitive in its cranial vault thickness and details of mandibular alveolar morphology (Alexeeva, 1997). At the time of discovery, Formozov arranged a commission of prehistorians to examine the circumstances of the burial and verify its antiquity (Alexeeva, 1997; Marks et al., 1997). Close examination revealed no evidence of an intrusive pit in the sediments, and most (but not all) of the committee members concluded that the burial was of Mousterian age (Alexeeva, 1997). Attempts to directly date the specimen have produced equivocal results, but fluorine analysis suggested that the specimen was younger than the associated fauna (Marks et al., 1997). Subsequent work at Starosel'e has greatly clarified the picture. During excavations in 1993 and 1994, Marks et al. (1997) recovered two additional human burials (an adult and a child) in the same area (within 3–6 m) as the original find. The adult skeleton was at the same stratigraphic level (below the uppermost Mousterian level) and was oriented (head to the west) and positioned (lying supine and extended, left hand on pelvis, face to the south) identically to the 1953 burial. The adult burial was found within a clearly identifiable burial pit, one that contained Mousterian artifacts that had been secondarily deposited in the grave fill. The recently discovered child's burial, like the one discovered in 1953, had its head towards the west

and was lying on its back (although the body appears to have been semiflexed rather than extended). This child's burial was stratigraphically higher than the other two, but like the original discovery it lacked an identifiable burial pit. The orientation and position of the burials, along with the presence of an historic Muslim graveyard near the site, led Marks et al. (1997) to argue that all three skeletons—including the Starosel'e child—represent late-medieval Muslim burials.

All four of these cases (Carigüela, Veternica, Svatý Prokop, and Starosel'e) concern situations in which the stratigraphic context and/or the archeological association of the fossils is highly questionable. While future efforts at direct dating may support the claimed antiquity of some of these specimens, we suspect that specimens with modern morphology are not likely to be found with the Mousterian, at least not in excess of ca. 35 ky BP. It is certainly true that no existing case provides compelling evidence for a modern human-Mousterian connection in Europe.

THE INITIAL UPPER PALEOLITHIC OF EUROPE

During Würm II/III (Hengelo) and IIIa times, there existed throughout Europe industries that combined Middle and Upper Paleolithic tool types and modes of production (technology). Often referred to as "transitional," these industries are generally considered as belonging to the Upper Paleolithic because of the occurrence of Upper Paleolithic blade technologies and tool forms.⁴ These Initial Upper Paleolithic in-

⁴It is reasonable to ask if IUP assemblages might better be considered as belonging to the final Middle Paleolithic, containing as they do elements of Middle Paleolithic technology and tool types. A number of issues make IUP typology especially thorny. If one employs a typological construct based on the frequencies of formal tools, then the blade-rich assemblages of the IUP should most reasonably be considered as Upper Paleolithic. However, the past few decades have seen a growing discomfort with classic Bordesian typology (including the Upper Paleolithic typology established by De Sonneville-Bordes and Perrot: see references in Reynolds, 1990), yet no new theoretical perspective has emerged to replace it (Harrold, 2000). What has emerged in the post-Bordesian era has been an increased emphasis on technology over typology in the interpretation of lithic assemblages, most notably illustrated by the recent florescence of studies of the *chaîne opératoire* (e.g., Bietti and Grimaldi, 1996). This change in emphasis has not necessarily clarified the position of the IUP, however. Blades, the sine qua non of the Upper Paleo-

dustries (to borrow the term applied by Kuhn et al. (1999) to comparable assemblages from Asia Minor) may be contemporaneous with other Upper Paleolithic (Aurignacian) industries in the same region, but generally do not show temporal overlap with the local Mousterian. Across Eastern and Central Europe, IUP assemblages are typically laminar (but with blades commonly produced by Levallois reduction), have both Middle Paleolithic (e.g., side scrapers, notched pieces, denticulates) and Upper Paleolithic type elements (e.g., end scrapers, burins), and contain bifacially worked foliates ("leaf points"). Most of the various IUP cultures of Central and Eastern Europe that are characterized by leaf points have at one time or another been seen as regional variants of the Szeletian, a culture defined at Szeleta Cave in the Bükk Mountains of Hungary (Allsworth-Jones, 1990a). Regional distinctions can be identified, however, and the possibility exists as well that the occurrence of leaf points in different regions may be the result, at least in some cases, of convergence (Allsworth-Jones, 1990a). Regionally defined leaf-point cultures include the Brynzeny, the Gordineshty, and the Kostenki-Streletsian (Streletskaya) of the Russian Plain (Anikovich, 1992), the Altmühlian of southern Germany, the Jerzmanowician of eastern Germany and Poland, the Bohunician of the Czech Republic (in which leaf points are relatively rare, leading to suggestions that this industry should be considered as a development separate from the Szeletian: Svoboda, 1988, 1990), and the Jankovichian (although this might best be seen as a Middle Paleolithic industry with leaf points: Gábori-Csánk, 1990) and the Szeletian *sensu stricto* of Hungary (see Allsworth-Jones, 1990a). Leaf points also occur in the early Upper Paleolithic of Belgium and Great Britain (at the

sites of Kent's Cavern, Spy, and Paviland), suggesting either a pan-European (at least to the east and north of the Alps) development of the Szeletian *sensu lato* or convergence in point morphology in different parts of Europe.

The IUP in France and northern Spain is represented by the Châtelperronian (also known as the Castelperronian or Lower Perigordian). While the Szeletian appears to have its greatest affinities with the Micoquian⁵ of Central Europe (since leaf points occur in the Micoquian: Allsworth-Jones, 1990a), the Châtelperronian looks as if its roots are in the Mousterian of Acheulian Tradition type B (MATb) of southwest Europe (Bordes, 1972). This association is based on a relatively high occurrence of Upper Paleolithic elements in the MATb, including burins, end-scrapers, and especially, backed knives (such as the Châtelperronian knife) (Harrold, 1989). In addition to these Upper Paleolithic type tools, the Châtelperronian shares with other IUP industries in retaining relatively high frequencies of Middle Paleolithic elements (side scrapers, denticulates, and notched pieces). Unlike most Mousterian assemblages, however, Châtelperronian assemblages can be rich in bone artifacts, including small and lozenge-shaped bone points, awls, baguettes, and beads and pendants (see d'Errico et al., 1998). The Châtelperronian appears to interstratify with the Aurignacian at three sites (le Roc de Combe and le Piage (Bordes and Labrot, 1967) in France, and El Pendo in Spain (González Echegaray, 1980)), although this claim has recently been challenged by Zilhão and d'Errico (1999) (see below).

In Italy the Mousterian gives way, at some sites, to an Upper Paleolithic culture called the Uluzzian which is characterized by crescent-shaped backed pieces, or lu-

lithic, can be produced in a variety of ways, and early forms of prismatic core reduction methods (as evidenced by the presence of crested blades), generally considered characteristic of the Upper Paleolithic, can be found in relatively old (even Middle Pleistocene) Mousterian assemblages (Bar-Yosef and Kuhn, 1999). Likewise, Middle Paleolithic style Levallois blade cores can be found in later Upper Paleolithic assemblages (Bordes, 1947; Newcomer, 1975). Given that there seems to be no perfect diagnostic criteria for classifying "transitional" industries, or for sharply demarcating Middle from Upper Paleolithic for that matter, we adhere to tradition in treating these industries as Upper Paleolithic (e.g., Harrold, 1989; Farizy, 1990).

⁵When the European Middle Paleolithic is contrasted with the whole of the Upper Paleolithic, it appears in comparison to lack substantial variation across space and through time. However, the Middle Paleolithic was not a monolithic entity, but instead a lithic culture with considerable regional and temporal complexity. In addition to the well-known facies of the Mousterian (Bordes, 1954, 1968), there were regional variants, such as the "Vasconian" Mousterian of Spain and the Pyrenees, as well as non-Mousterian variants of the Middle Paleolithic, such as the "Micoquian" of Central Europe (see Harrold, 1989; Svoboda et al., 1996).

nates, as well as end scrapers, side scrapers and burins, and bone points or *sagaies* (Palma di Cesnola, 1993). First identified at sites on the Bay of Uluzzo in the south of Italy (on the Ionian coast of Apulia, the "bootheel" of the peninsula), the Uluzzian occurs as far north as Tuscany (Palma di Cesnola, 1993), but is not known from central Italy (Zampetti and Mussi, 1988). This industry has also been argued to be a regional variant of the Châtelperronian, in which backed crescents take the place of backed knives (Gioia, 1988).

Despite good archeological representation of IUP industries, the makers of these assemblages are still poorly known. Human remains have been recovered from IUP levels at only seven sites (although a few hominid-bearing sites with Aurignacian-type tools might be added to this list: see below). These human remains (reviewed below) have tended to be isolated teeth and very fragmentary bones, frustrating attempts to make taxonomic attributions.

Châtelperronian

The best known of the IUP fossils are the Neandertal remains from Châtelperronian levels at La Roche à Pierrot (Saint Césaire: Lévêque and Vandermeersch, 1980; Vandermeersch, 1984) and the Grotte du Renne (Arcy-sur-Cure: Leroi-Gourhan, 1958; Hublin et al., 1996). The former comprises a partial skeleton of an adult male, recovered from an apparent burial in the higher of two Châtelperronian levels at the site (EJOP supérieur). Six burnt flints from this level were dated by thermoluminescence, resulting in a mean calendar age of 36.3 ± 2.7 ky BP (Mercier et al., 1991). The St. Césaire skeleton is by far the most complete and informative specimen associated with the IUP in Europe. In craniofacial and postcranial morphology, St. Césaire 1 clearly conforms to a Neandertal pattern (Lévêque and Vandermeersch, 1980; Vandermeersch, 1984; Stringer et al., 1984; Trinkaus et al., 1998, 1999), albeit with some details of anatomy that are closer to modern human morphology (such as reduced midfacial prognathism, greater craniofacial gracility, reduced nasal piriform aperture width, and great width and projection of the humeral

deltoid tuberosity: Trinkaus et al., 1999; Wolpoff, 1999). Geometric analysis of long-bone cross sections suggests that in some aspects of behavior, most notably locomotor levels, St. Césaire was more similar to Early Upper Paleolithic modern humans than Middle Paleolithic Neandertals (Trinkaus et al., 1998, 1999).

The remains from Arcy-sur-Cure include nine isolated teeth and a fragmentary temporal bone from an infant. On the basis of size and morphology, especially the expression of taurodontism in the recovered molars, Leroi-Gourhan (1958) attributed the remains to Neandertals. Given the uncertainty associated with classifying fossil material based on isolated teeth, and the prevailing idea (until the discovery of St. Césaire) that the Châtelperronian was made by modern humans (see discussion of Combe Capelle, below), Leroi-Gourhan's attribution was for a long time considered very tentative. Indeed, Brose and Wolpoff (1971) even saw the dental material from Arcy-sur-Cure as indicative of a high degree of Neandertal affinities in the earliest modern humans in France. High-resolution computed tomography of the temporal bone in 1996 revealed a morphology of the bony labyrinth of the inner ear characteristic of Neandertals (Hublin et al., 1996). While not all Neandertals are characterized by an identical bony labyrinth morphology (Ponce de León and Zollikofer, 1999), the pattern noted in the Arcy specimen appears to solidify its Neandertal affinities. The temporal bone, derived from layer Xb, has been dated by ^{14}C to 33.8 ± 0.7 ky BP (Hedges et al., 1994). Given the roughly 10% age underestimation by ^{14}C in this time range, the dates from St. Césaire and Arcy-sur-Cure are highly concordant. It bears reiterating—given the questions that surround the cultural capacities of Neandertals—that Châtelperronian levels at Arcy-sur-Cure and elsewhere have produced numerous items of personal adornment (see Zilhão and d'Errico, 1999).

To these remains we can add an isolated tooth from Châtelperronian levels at Font de Gaume, from the Dordogne of southwestern France (Gambier et al., 1990). The tooth is an incompletely formed crown of a perma-

nent right C_1 , and based on the degree of crown formation it probably derived from a child of 2–4 years (Gambier et al., 1990). As with many Neandertal and modern human mandibular canines, the crown has a large median crest, separated from the marginal crests by distinct grooves. The region of the lingual cingulum is not fully formed, thus the morphology of this feature cannot be evaluated. The specimen lacks the common Neandertal characteristics of an expanded distal border and a distolingual tubercle, but as noted by Gambier et al. (1990), the expression of these features is variable within Neandertals. According to Gambier et al. (1990), this isolated tooth crown does not provide enough information to securely attribute it to (or exclude it from) either Neandertals or early modern humans.

Another possibly Châtelperronian-associated human fossil, this time a nearly complete adult male, was recovered by Otto Hauser from the site of Combe Capelle (Dordogne, France) in 1909 (Klaatsch and Hauser, 1910). The skeleton (destroyed during the Allied bombing of Berlin in World War II) was that of an anatomically modern human, leading to the widespread misconception for the better part of the 20th century that the Upper Paleolithic, in all of its forms, was equated with modern humans. According to Gambier (1989), the excavations at Combe Capelle were conducted mainly by workmen and lacked stratigraphic control, and the stratigraphy of the site and the provenience of the skeleton remain open to interpretation. Gambier (1989) also notes that, morphologically, the Combe Capelle specimen would fit better in a sample of more recent Europeans than it would with Upper Paleolithic modern humans, and she suggests that the skeleton may have been an intrusive burial from more recent times. Given the questions surrounding the archeological provenience and morphological affinities of the skeleton, and seeing as the fossil is no longer available for direct dating or further study, the Combe Capelle skeleton cannot be considered evidence of a modern human-Châtelperronian connection.

Uluzzian

Two human milk teeth were found in 1965 in Uluzzian level E at Grotta del Cavallo (Palma di Cesnola and Messeri, 1967), the type site if not the eponymous site for the Uluzzian (Palma di Cesnola, 1993). Recovered near the base of level E (EIII or possibly EII), the remains include a left dm^1 and, from 15–20 cm higher in the level, a right dm^2 . Level EIII contains an “early Uluzzian” (Palma di Cesnola, 1993), and is likely greater than 31 ky BP based on a single ^{14}C determination from the upper part of level E (EII-I) (Bietti, 1997). The earliest Uluzzian at the Campanian site of Grotta di Castelcivita yielded radiocarbon dates clustering around 33–32 ky BP (Bietti, 1997), likely the same approximate age as the material in the base of Cavallo level E.

The Cavallo dm^1 is large-crowned, measuring 11.0 mm mesiodistally (MD) by 7.5 mm buccolingually (BL). To Messeri and Palma di Cesnola (1976), the overall dimensions and morphology of this tooth compared favorably to European early modern human samples. On the basis of the published crown dimensions, the Cavallo dm^1 appears to us to be more closely aligned with Neandertals. The mesiodistal diameter of the tooth is large, well above the mean values of both Neandertals and early modern humans (Neandertals, 8.6 ± 1.1 , $n = 9$; early modern humans, 7.3 ± 0.6 , $n = 10$: data from Frayer, 1978), but closer to that of the Neandertals. The buccolingual dimension is small relative to both groups (Neandertals, 8.7 ± 1.0 , $n = 9$; early modern humans, 8.7 ± 0.6 , $n = 9$: data from Frayer, 1978). These dimensions produce a computed crown area (MD * BL) of 82.5, more than two standard deviations above the mean early Upper Paleolithic mean (63.3 ± 8.2 , $n = 9$) but within one standard deviation of the mean for a sample of Neandertals (75.1 ± 10.0 , $n = 9$: all data from Frayer, 1978). The tooth is mesiodistally large relative to its buccolingual dimension, which is opposite the condition usually seen in both Neandertals and early modern humans (although this morphology can be seen in the presumably Neandertal dm^1 from

Gibraltar). According to Palma di Cesnola and Messeri (1967), the tooth has a rather large pulp chamber, which may suggest taurodontism, but which would also not be unusual for an early modern human deciduous molar (see below). In short, there is nothing in this tooth to rule out the possibility that it derived from a Neandertal, or a modern human for that matter, although we feel that its dimensions more closely align it with the former.

The Cavallo dm^2 , from stratigraphically higher in level E, is similar to Neandertal specimens in size, cusp morphology, and taurodontism (Messeri and Palma di Cesnola, 1976). Measuring 10.0 mm (MD) by 11.0 mm (BL), the Cavallo dm^2 has a crown that is large relative to, but within the range of, early modern human values. Both its MD and BL diameters are close to but above mean values for small samples of Neandertals and early modern humans (MD, 9.8 ± 0.8 for 13 Neandertals, 9.6 ± 0.8 for 5 early modern humans; BL, 10.3 ± 0.8 for 13 Neandertals, 10.5 ± 0.5 for 10 early modern humans: data from Frayer, 1978), and accordingly its computed crown area is somewhat above that of both groups (Cavallo, 110 mm; Neandertals, 101.5 ± 14.8 , $n = 13$; early modern humans, 103.3 ± 13.4 , $n = 4$: data from Frayer, 1978). Thus, metrically, the Cavallo dm^2 could fit with either sample, and only the observed taurodontism and occlusal morphology (see Palma di Cesnola and Messeri, 1967, p. 258) suggest attribution to Neandertals. Taurodontism is generally characteristic of Neandertal deciduous molars (although it is often obfuscated by root resorption) and is not evident in any of the early modern human juveniles ($n = 16$) radiographed by Skinner and Sperber (1982). Some of these early modern human specimens (e.g., Laugerie-Basse 4 and Badger Hole) have somewhat enlarged pulp cavities but do not approach the condition seen in Devil's Tower (Gibraltar) and La Quina 18. Thus the presence of taurodontism in this specimen would appear to link it with the Neandertals. Palma di Cesnola and Messeri (1967) were also struck by the extreme occlusal wear in this specimen (which made difficult their observation of cusp morphology), a feature they felt re-

flected a tough vegetal diet. Unfortunately little is known about wear patterns in juvenile Neandertal and early modern human teeth, and thus group assignment based on occlusal wear is clearly not justified.

Szeletian

Two sites have produced human fossils in association with Szeletian (or Szeletian-like) assemblages. In the Upper Remete Cave at Mariaremete (Hungary), a single culture-bearing horizon produced a tiny sample of lithics ($n = 13$) and a single marine shell thought to have been collected by humans (Allsworth-Jones, 1990a). The lithics include Mousterian-type tools (side scrapers and flakes) made by Levallois reduction, and five bifacially worked implements, considered by Gábori-Csánk (1983) to be bifaces or bifacial scrapers. The overall character of this small assemblage appears to be Jankovichian (Szeletian *sensu lato*: see Allsworth-Jones, 1990a), and according to Gábori-Csánk (1983, p. 284), "a modified form of the Micoquian." These bifacial pieces were thought to be leaf points by Allsworth-Jones (1990a), and the assemblage from Mariaremete could just as well be pre-Szeletian, namely a late Micoquian or Mousterio-Levalloisian with leaf points (Allsworth-Jones, 1990a; Kozłowski, 1996). Also in this archeological level (layer 4) were found three heavily worn teeth, a right I_1 , I_2 , and C_1 , all thought to belong to a single Neandertal individual (Allsworth-Jones, 1990a). Unfortunately, no morphologically detailed defense of this attribution is given.

The Slovakian site of Dzeravá Skála (or Pálffy) produced the germ of a left M_2 from a cryoturbated sediment containing both Aurignacian and Szeletian type artifacts (massive-base bone points and leaf points, respectively). Although soliflucted, the sediments showed some cultural superposition, with the leaf points being more abundant in the lower portion (Prošek, 1951). The molar was described by the site's excavator, J. Hillebrand, as having a well-developed fovea anterior and as being generally similar to the Krapina Neandertal mandibular molars (Hillebrand, 1914). Recent reassessments of late Pleistocene fossil human remains from

the former Czechoslovakia (Svoboda et al., 1996) provide no further information on the Dzeravá Skála tooth. Thus the conclusion that this specimen could be either Neandertal or early modern human (Smith, 1984) is still valid. The same interpretation would also apply for the Remete teeth (see above).

The Makers of the IUP

Based on the limited fossil evidence available to us now, we can say only that 1) the Mousterian and other European Middle Paleolithic industries (such as the Micoquian at Kůlna) appear to have been made exclusively by Neandertals, 2) IUP industries, with the exception of the Bachokirian (which is treated with the Aurignacian below, and can likely best be considered a proto-Aurignacian or early archaic Aurignacian: Kołowski, 1996), appear to have their roots in the late Middle Paleolithic industries of their respective regions, 3) Neandertals were making some of these IUP industries (at least the Châtelperronian in France), and 4) all of the human fossils yet recovered from IUP contexts for which any indication of diagnostic morphology is present have their greatest morphological affinities with Neandertals and not early Upper Paleolithic modern humans. In short, there is nothing in the archeological or paleontological records to refute the claim that the various manifestations of the non-Aurignacian earliest Upper Paleolithic represent in situ cultural evolution from Middle Paleolithic (usually Mousterian) antecedents, and at the hands of Neandertals (cf. Kozłowski, 1996; Allsworth-Jones, 1990a). However, it must be remembered that, except for the Châtelperronian, the fragmentary and often undiagnostic nature of fossil human associations with IUP components does not allow this conclusion to be made in a definitive fashion.

HUMAN FOSSILS FROM THE EARLIEST AURIGNACIAN

Both the timing of the appearance of the Aurignacian and its typological characteristics are issues of current debate. Prehistorians have relied heavily on the classic sequence of five Aurignacian stages delin-

eated by Peyrony (1933), based largely on the sequence of assemblages in southwestern France. The earliest of Peyrony's stages, Aurignacian I, was characterized by blades with scalar retouch (Aurignacian blades), end-scrapers on Aurignacian blades, stranded blades, carinated and nosed end-scrapers fashioned on thick flakes or chunks, burins (although rare) and awls, batons de commandements, and split base points made from bone (Bordes, 1968). The split-base bone point has played the role of *fossile directeur* for the early Aurignacian, a detail that has complicated efforts to classify assemblages outside of France. Often these non-French manifestations are lithically not like the Aurignacian but contain split-base and other bone points (e.g., Montet-White, 1996). In France, the Aurignacian I gave way to the Aurignacian II, in whose assemblages lozenge-shaped points replace split-base points, Dufour bladelets are common, and the busked burin assumes the role of type-fossil. De Sonneville Bordes (1960) added an earlier, "Aurignacian 0," stage to Peyrony's scheme. This came from the recognition that what Peyrony had called "Périgordian II," which lacked split-base bone points and Aurignacian blades and which commonly had Dufour bladelets, was Aurignacian in its other attributes (Harrold, 1989). Aurignacian 0 (also variously called the Corrézian, the Archaic Aurignacian, Basal Aurignacian, Aurignacian Ancien, or proto-Aurignacian) has only rarely been found outside of France, and the defining characteristics of the early Aurignacian remain a matter of continuing debate (see Harrold, 1989; Montet-White, 1996; Miracle, 1998).

The use of type-fossils for classifying artifact assemblages is clearly laden with problems: bone points, for example, do not appear in all early Aurignacian assemblages, and do appear in some later Mousterian assemblages (e.g., at Große Grotte (Riek, 1934; Albrecht et al., 1972) and Salzgitter-Lebenstedt (Gaudzinski, 1999), both in Germany: see also Montet-White, 1996); Aurignacian assemblages may also occasionally contain type-fossils from other industries, such as Châtelperron knives or leaf points. Bordes (1968) clearly recognized

this problem and advocated that relative frequencies of retouched tool types, rather than *fossiles directeurs*, should be used to compare assemblages (see Miracle, 1998). But even this approach is fraught with problems of intra- and intersite variability, small sample sizes, and sampling error that make discrimination of assemblages difficult. Finally, it is not entirely clear that the concept of unified lithic industries, representing cultural commonality, can be applied in a pan-European context. As observed by Straus (1995, p. 4):

... there is little purpose in repeating the traditional, normative characterizations of the classic industries, for it has been shown in recent years that all of them are highly variable internally, intra- and interregionally, synchronically and diachronically, among and within individual sites. Much of this variability can be explained in terms of sampling factors, differences in activities or site functions, artifact disposal modes, and differences in raw materials. The stylistic or ethnic aspects of Upper Paleolithic industries continue to be hotly debated, but it is difficult to imagine that ethnically bounded units existed in the same sense that modern "cultures" have existed over thousands of years and kilometers.

In short, archeologists are confronted with many of the same problems in trying to classify artifact assemblages as paleontologists are in classifying fossils: uncertainty about the validity of the typologic or taxonomic units, disagreement and doubts about the appropriate diagnostic criteria, uncertainty about how to interpret sites or specimens with mixed diagnostic features, and small, fragmentary, and generally inadequate samples for analysis. Added to these difficulties are ambiguities in dating, particularly with older excavations in which stratigraphic complexity was not fully appreciated and in which contamination of samples for conventional ^{14}C determinations was not controlled. This situation has made research on the biological and cultural interactions between Neandertals and early modern humans, and between Mousterian and Upper Paleolithic peoples, especially hard to decipher. Symptomatic of this difficulty is the current debate about the relative chronological and stratigraphic positions of IUP and Aurignacian industries. The Châtelperronian, for example, has conventionally been thought to interstratify

with the Aurignacian at some sites (le Roc de Combe, le Piage, and El Pendo: Bordes and Labrot, 1967; González Echegaray, 1980), and this observation has formed the cornerstone of Châtelperronian/Aurignacian acculturation scenarios. It has been argued, however, that when due consideration is given to taphonomic factors and problems with radiocarbon contamination and calibration, the remaining well-dated sites reveal first an emergence of IUP cultures in various regions, followed in time by the appearance of the Aurignacian (d'Errico et al., 1998; Zilhão and d'Errico, 1999). The reexamination by Zilhão and d'Errico (1999, p. 43) of the archeological record of the Interpleniglacial led them to claim, "(n)owhere in Europe does the true Aurignacian—with its characteristic bone or ivory points and stone barbs—date to before ca. 36,500 radiocarbon years ago." Zilhão and d'Errico's perspective has not gone unchallenged (e.g., Harrold, 2000; Richter et al., 2000; and comments in d'Errico et al., 1998), and this remains an issue of heated debate.

Below, we examine the sites that have produced human fossils in association with the earliest Aurignacian. These include some sites in which fossils have been found with diagnostically Aurignacian assemblages, others in which human remains have been found in association with Aurignacian type-fossils but in which the appropriate classification of the entire lithic and bone industry is unclear, and some with human remains with no archeological context but with direct dates that would suggest an Interpleniglacial age. There is an abundant, albeit generally fragmentary, fossil record from the later Aurignacian of Western Europe. A number of sites have yielded human remains in association with Peyrony's Aurignacian 1, such as La Crouzade, Isturitz, and Les Rois in France (Gambier, 1989), Fontana Nuova in Italy (Chilardi et al., 1996), and Istállöskö in Hungary (Vértes and de Vries, 1952; Malán, 1954). In France, the Aurignacian 1 has ^{14}C dates clustering around 31.5–30.5 ky BP (Delibrias and Fontugne, 1990). At ca. 30 ky BP in age (Movius, 1969), the modern human remains found with an evolved Aurignacian assemblage (De Sonneville Bordes,

1959) at Cro-Magnon can also be placed with this group. In every case that a confident taxonomic diagnosis can be made, these later Aurignacian remains represent modern humans (see Gambier, 1989, 1993, 1997). There is a temptation to view these early modern humans as the sole proprietors of the Aurignacian, and to deputize the Cro-Magnon to fill the early Aurignacian fossil void. In truth the makers of the earliest Aurignacian are not well-known, despite a growing (but still diagnostically difficult) fossil record. We have thus limited our review to human fossils associated with the earliest Aurignacian, and present the fossil record in roughly chronological order and without regard to geography. In general we devote somewhat greater attention to the more diagnostically difficult material (simply because it is more difficult to diagnose and therefore warrants greater attention to detail).

El Castillo (Santander, Spain)

The cave of El Castillo, with 20 m of stratified cultural deposits spanning virtually the entire duration of the European Paleolithic, is one of the cornerstones of Spanish prehistory. Excavation was undertaken in 1910 by Hugo Obermaier (in collaboration with other noted prehistorians of the day, including the Abbé Breuil and Paul Wernert), and by 1912 Aurignacian levels in the cave had been reached (Cabrera Valdés, 1984). Obermaier (1924) identified three cultural levels containing Aurignacian artifacts: layer o, a late Aurignacian containing graves and typical Gravette points, underlain by a sterile clay layer n; layer m, another late Aurignacian level, underlain by a nearly sterile clay layer i; layer h, with Obermaier's "Aurignacian delta," underlain by a sterile stalagmitic layer g (actually a sterile silt; Butzer, 1981), and below that, a layer (f) containing a typical Mousterian assemblage. Analysis of cultural material from stratum h (now designated level 18) excavated by Obermaier and later (beginning in 1980) by Victoria Cabrera Valdés reveals an assemblage characteristic of the basal Aurignacian of Cantabrian Spain (Cabrera Valdés, 1984). Artifacts recovered from level 18 include split-base bone points

(more common in the lower portion of the layer), Aurignacian blades, nosed and carinated end scrapers, and occasional dihedral burins (Cabrera Valdés, 1984). A single Châtelperronian point was also recovered from level 18 (Cabrera Valdés and Bischoff, 1989). Initial AMS radiocarbon determinations on three small pieces of charcoal from level 18 yielded dates ranging from 40.0 ± 2.1 to 37.7 ± 1.8 ky BP (Cabrera Valdés and Bischoff, 1989). Seven additional determinations, performed by two different laboratories, have reinforced the original dates, and suggest that the base of level 18 (18c) was deposited during the beginning of the Hengelo Interstadial, at approximately 40 ky BP, while the top of the level (18b1) accumulated around 38.5 ky BP (Cabrera Valdés and Bernaldo de Quiros, 1996).

In the course of the early excavations at El Castillo, Obermaier recovered human fossil material from the basal Aurignacian level 18. The remains derive from at least two individuals, an adult (El Castillo B) and a child of 3–5 years (El Castillo C) (Garralda, 1989, 1997). Detailed descriptions of the human remains were never published, and the fossils are now lost. Brief accounts of the Castillo human material have been put forth by Garralda (1989) and Garralda et al. (1992), based on an unpublished 1933 description of the material by Henri Vallois. The adult remains included a slightly worn right mandibular second molar and three small yet robust cranial fragments. The child was represented by a partial mandible (Fig. 3), preserved from the region of the symphysis to the right-side unerupted first permanent molar and containing the first and second deciduous molars (and the first adult molar in its crypt), as well as seven small cranial fragments (Garralda, 1989; Garralda et al., 1992).

As to the morphologic affinities of the Castillo Aurignacian people, the dental dimensions (Table 2) are largely uninformative. The El Castillo B adult mandibular second molar is relatively large by both Neandertal and early modern human standards, but could fit comfortably within the range of variation of either group in terms of both size and shape (Table 2). Both of the El Castillo C deciduous molars have mesiodis-



Fig. 3. El Castillo C mandibular fragment in occlusal (top) and inferior (bottom) views. Redrawn from Garralda et al. (1992).

tal (MD) diameters equal to or greater than the mean values for both comparative groups, but exhibit small buccolingual (BL) diameters (Table 2). The El Castillo C dm_1 is mesiodistally long relative to a sample of two early modern humans, but falls right on the Neandertal mean (also from a small sample) for this dimension. However, the dm_1 is more than three standard deviations below the mean of the Neandertal sample in BL diameter, yet is close to the mean derived from two early modern humans. This results in a crown surface area intermediate between the two samples (but some 6.7 standard deviations below the Neandertal mean) and a crown index well below the

mean of two modern humans (and farther still [1.5 standard deviations] below the Neandertal mean). The same pattern is seen in the El Castillo C dm_2 , with the exception being that its crown area is very close to the early modern human sample mean (this time based on six specimens). The crown index in the El Castillo C dm_2 is 2.5 and 1.9 standard deviations below the early modern and Neandertal means, respectively. Garralda (1997) noted that the symphysis of the El Castillo C mandible is robust and lacks an accentuated chin, noting (p. 158), "The human remains from El Castillo confirm the general robusticity of early Upper Paleolithic humans and also show some archaic features, but it is impossible to classify them as 'evolved' Neandertals or 'archaic' modern humans." Based on the limited amount of information available on these remains, we agree that an unequivocal assessment of their affinities is not possible.

Bacho Kiro (Balkan Mountains, Bulgaria)

The fragmentary human remains from Bacho Kiro Cave, Bulgaria, enter into virtually every consideration of the Middle-to-Upper Paleolithic and Neandertal/modern human transitions. Associated with an "Aurignacoid" lithic and bone industry (Kozłowski et al., 1982), the oldest of these remains derive their importance first from radiometric dates that may grant them status as the earliest known makers of the Upper Paleolithic in Europe (but see below), and second from typological and taxonomic ambiguities in the lithic and hominid fossil samples, respectively, that allow considerable latitude in their interpretation. These remains have been variously seen as representing the earliest modern human makers of the Aurignacian, as modern humans associated with an IUP industry, or even as possible Neandertals with an IUP or even Aurignacian association (see Wolpoff, 1996; Miracle, 1998).

A total of eight human fossils was recovered from four stratigraphic levels at Bacho Kiro (Glen and Kaczanowski, 1982). Seven of these fossils can reasonably be placed into three temporal groups (the eighth specimen, a deciduous mesial incisor crown, is not well

TABLE 2. Dimensions of teeth from El Castillo, level 18, relative to Neandertals and early modern humans¹

	Neandertals	El Castillo	Early moderns
<i>M</i> ₂			
Mesiodistal length	11.8 ± 0.7 (26)	12.0	11.3 ± 1.0 (22)
Buccolingual breadth	11.3 ± 0.7 (26)	11.5	10.8 ± 0.8 (22)
Computed crown area	132.9 ± 14.3 (26)	138.0	122.6 ± 19.0 (20)
Crown index	95.7 ± 5.6 (26)	95.8	96.9 ± 5.0 (20)
<i>dm</i> ₁			
Mesiodistal length	9.0 ± 0.5 (7)	9.0	8.6 (2)
Buccolingual breadth	7.7 ± 0.2 (7)	7.0	7.1 (2)
Computed crown area	69.1 ± 0.9 (7)	63.0	60.3 (2)
Crown index	85.8 ± 5.4 (7)	77.8	82.4 (2)
<i>dm</i> ₂			
Mesiodistal length	10.6 ± 0.6 (14)	11.0	10.6 ± 0.6 (6)
Buccolingual breadth	9.7 ± 0.5 (14)	9.0	9.4 ± 0.6 (6)
Computed crown area	102.7 ± 9.7 (14)	99.0	99.1 ± 11.2 (6)
Crown index	91.4 ± 4.9 (14)	81.8	88.8 ± 2.8 (6)

¹ Dimensions of El Castillo teeth from Garralda (1997); Neandertal and early modern human data from Frayer (1978). Computed crown area = mesiodistal length * buccolingual breadth. Crown index = 100 * buccolingual breadth/mesiodistal length.

TABLE 3. Stratigraphic context of Bacho Kiro human fossils¹

Bacho Kiro specimen no.	Element	Level	Carbon 14 date	Cultural association
559	Right mandibular corpus with <i>dm</i> ₂ and <i>M</i> ₁	6a/7	29.15 ± 0.95 ky BP	Aurignacian
1702	RP ⁴	6a/7	29.15 ± 0.95 ky BP	Aurignacian
1704	RC ¹	6a/7	29.15 ± 0.95 ky BP	Aurignacian
2641	RI ₂	7	None	Aurignacian
3575	Right parietal fragment	7	None	Aurignacian
2823	RI ₁	7/6b	32.15 32.7 ± 0.3 ky BP	Aurignacian?
1124	Left mandibular corpus with <i>dm</i> ₁	11-IV	>43.0	Bachokirian ("proto-Aurignacian")
W-1	<i>di</i> ₁	?	None	?

¹ From Kozłowski (1982).

provenienced and is not considered further here) (Table 3).

The first, and stratigraphically oldest, group contains a single fossil: a fragment of the left side of a mandibular corpus containing a first deciduous molar. This specimen was recovered from level IV at the base of layer 11 (Ginter and Kozłowski, 1982b), along with artifacts classified as Bachokirian (an "Aurignacoid" early Upper Paleolithic industry of Central Europe: see below). Level 11 occurs between 354–380 cm below datum (Ginter and Kozłowski, 1982a), with subunit IV present at a depth of 375–380 cm. Charcoal from the top of layer 11 (at a depth of 356–357 cm) was dated by conventional radiocarbon to be >43 ky BP (Mook, 1982). Ginter and Kozłowski (1982b) place layer 11 in a period of warming and humidification based on sedimentological analysis, a greater abundance of *Pitymys subterraneus* relative to

the more dry-habitat *Microtus arvalis*, and an increased abundance of fish and the marsh-loving European mole, *Talpa europaea*. If the radiocarbon date for the upper reaches of layer 11 is correct, then this warm period may correspond to the Moershoofd (Heraklitsa) temperate oscillation (Ginter and Kozłowski, 1982b), making the Bachokirian the earliest dated Upper Paleolithic in Europe. However, bone, charcoal, and dental samples from layer 11 submitted to the Oxford accelerator laboratory in 1990 produced AMS radiocarbon dates ranging from 38.5 ± 1.7 to 33.8 ± 0.9 ky BP (Hedges et al., 1994). Two of these dates (38.5 ± 1.7 ky BP on bone and 37.7 ± 1.5 ky BP on charcoal) are not significantly different from one another, but are more than two standard deviations older than the two youngest dates obtained from layer 11 (34.8 ± 1.2 ky BP on a tooth, and 33.8 ± 0.9 ky BP on bone). These younger dates suggest that the

TABLE 4. Dimensions of dm_1 from Bacho Kiro, level 11, relative to Neandertals and early modern humans¹

	Neandertals	Bacho Kiro	Early moderns
Mesiodistal length	9.0 ± 0.5 (7)	8.8	8.6 (2)
Buccolingual breadth	7.7 ± 0.2 (7)	7.5	7.1 (2)
Computed crown area	69.1 ± 0.9 (7)	66.0	60.3 (2)
Crown index	85.8 ± 5.4 (7)	85.2	82.4 (2)

¹ Dimensions of Bacho Kiro 1124 from Glen and Kaczanowski (1982); Neandertal and early modern human data from Frayer (1978). Computed crown area = mesiodistal length * buccolingual breadth. Crown index = 100 * buccolingual breadth/mesiodistal length.

warmer and wetter conditions reflected in the layer 11 sediments correspond to the Hengelo (Podrahem) interstadial rather than the Heraklitsa.

As pointed out by Mellars (in Hedges et al., 1994), the range of dates from layer 11 indicates either stratigraphic misplacement of samples, serious contamination effects, or a long duration for the accumulation of the layer. A similar situation occurs at Temnata Cave, also in the Bulgarian Balkan Mountains. Here artifacts attributed to the Bachokirian are distributed throughout a single level (layer 4), with radiocarbon dates suggesting a 5,000–9,000 year period of accumulation of the sediments (Ginter et al., 1996). Recent ¹⁴C AMS determinations place the occupation at the bottom of Temnata layer 4 between 39.1 ± 1.8 and 38.3 ± 1.8 ky BP, while the top of the layer dates to between 33.0 ± 0.9 and 31.9 ± 1.6 ky BP (Ginter et al., 1996). If the Bachokirian occupations of Bacho Kiro and Temnata were penecontemporaneous, the dates from Temnata would support a Hengelo/Podrahem date for Bacho Kiro layer 11. The emergence of the Bachokirian, then, may correspond to the emergence of the Upper Paleolithic generally across all of Europe.

The single human specimen from Bacho Kiro layer 11 does not provide many useful features for taxonomic classification. The deciduous first molar in this mandibular fragment was described by Glen and Kaczanowski (1982) as having a relatively worn occlusal surface and a large mesio-buccal tubercle. The crown dimensions are intermediate between small samples of Neandertals and early modern Europeans (Table 4). The buccolingual diameter of the crown is relatively large, and in this feature and in its relatively high crown index (produced by the large BL diameter), the specimen is closer to the Neandertal mean. Indeed, Wol-

poft (1996) noted that the layer 11 molar has exactly the same dimensions as the Neandertal dm_1 from Taubach. However, small sample sizes prohibit a reliable assessment of the range of variation in the comparative samples, and it is unlikely that the dimensions of the Bacho Kiro tooth are significantly different than those of early Upper Paleolithic modern humans. Radiography (Glen and Kaczanowski, 1982, p. 75) revealed a nontauroid root to the dm_1 , which might suggest modern human affinities. As previously noted, the Neandertal deciduous molars reported by Skinner and Sperber (1982) are characterized by taurodontism, as is the Uluzzian-associated Cavallo dm_2 .

Kozłowski et al. (1982) place the lithic assemblage in layer 11 into an "Aurignacoidal tradition," but as "Bachokirian" rather than true Aurignacian. Assemblages that have been classified as Bachokirian are known from only a handful of other sites, including Istállöskö in Hungary, and Temnata Cave, Pest, and V. Levski in Bulgaria (Hahn, 1993). The lithic elements of the Bachokirian are typologically and technologically Aurignacian, emphasizing blade production from cores with typical UP preparation (single- and opposite-platform cores), retouched blades, carinated end-scrapers, and with Aurignacian retouch on some retouched blades (Delporte and Djindjian, 1979; Kozłowski et al., 1982). Perforated bear and fox teeth were recovered from layer 11, suggesting personal adornment as is generally characteristic of early Upper Paleolithic cultures. These features have led many researchers to consider the layer 11 assemblage as a very early or "proto-Aurignacian" (e.g., Mellars in Hedges et al., 1994), archaic Aurignacian (Kozłowski, 1996), or Early Balkan Aurignacian (Ginter et al., 1996). The main distinction between

it and more classic Aurignacian assemblages lies in the absence of bone points in the Bachokirian (which is also characteristic of the basal Aurignacian [Aurignacian 0] in France). It is also interesting that, unlike other IUP industries, the Bachokirian represents a break with the local Mousterian in having a fully developed Upper Paleolithic method of blank production (with no discernible tradition of the Levallois technique) and a low count of typologically Middle Paleolithic elements (e.g., side-scrapers, points), suggesting it is allochthonous (Kozłowski, 1996), possibly with ties to the early Aurignacian (Baradostian) of the Zagros Mountains (Olszewski and Dibble, 1994). The Bachokirian also differs from Central European IUP cultures, but shares with the Aurignacian, in its lack of leaf points and backed pieces (Kozłowski et al., 1982).

The second group of human fossils from Bacho Kiro includes a right central permanent mandibular incisor from the level 7/6b interface, and a fragment of a right parietal and a right lateral permanent mandibular incisor from level 7. The top of level 6b (below the contact with level 7)⁶ has been radiocarbon dated to 32.7 ± 0.3 ky BP (Mook, 1982), and according to Glen and Kaczanowski (1982), the human I₁ from the interface of 7/6b was radiocarbon dated to 32,150 years BP (errors and other details are not given by the authors). The level 7/6b interface yielded 76 lithic and four bone artifacts (Kozłowski et al., 1982). The lithics included end-scrapers, burins, retouched blades, retouched flakes, and side scrapers, and the osseous artifacts included a bone point with a triangular cross section. While clearly Upper Paleolithic in character, the level 7/6b assemblage is too small to allow for a confident assessment of its typological attributes (Kozłowski et al., 1982). The middle of level 7 contained a larger lithic sample (654 pieces) but only slightly more bone tools (11), including the base of a bone point, oval in section (Kozłowski et al., 1982). The lithic and osseous assemblages in this level are

generally similar to those of level 7/6b, and Kozłowski et al. (1982) classified this assemblage as typical (Balkan) Aurignacian. Sedimentological and faunal data suggest dry but relatively warm conditions as level 7 began to form, but with increasingly cooler temperatures throughout level 7 times (Ginter and Kozłowski, 1982b). The radiocarbon determinations and the climatic indicators suggest that the base of level 7 was deposited during the early part of the Denekamp temperate period.

As with the material from level 11, the human remains from level 7 do not provide much diagnostic information. The parietal fragment is thick (5 mm), but within the range of variation for recent humans (2–5 mm: Glen and Kaczanowski, 1982). The two adult mandibular incisors from levels 7/6b and 7 have their greatest size and shape similarity with the early Upper Paleolithic sample (Table 5). Both of these incisors have reduced BL diameters relative to Neanderthals, resulting in incisors that have crown indices that are very close to the modern human sample means but more than one standard deviation away from Neanderthal means.

The third group of human fossils from Bacho Kiro derives from the contact between levels 7 and 6a. Artifacts from this depth include nosed and carinated end-scrapers, Dufour bladelets, and bone points with circular cross sections, leading Kozłowski et al. (1982) and Ginter and Kozłowski (1982b) to consider them representative of the typical Aurignacian. A single ¹⁴C determination from the 6a/7 contact gave a date of 29.2 ± 1.0 ky BP (Mook, 1982), and climatic indicators suggest relatively warm and humid conditions (Ginter and Kozłowski, 1982b), which may indicate deposition during the Denekamp interstadial.

The human remains from the 6a/7 contact include a fragment of right-side mandibular corpus containing the second deciduous molar and the first permanent molar, a right maxillary permanent fourth premolar, and a right maxillary permanent canine. Again, the available fossil evidence is fragmentary and includes juvenile specimens, making taxonomic diagnosis difficult. The ambiguity inherent in taxonomically diagnosing

⁶The strata at Bacho Kiro are numbered, from highest to lowest, as follows: 1, 2, 3, 4, 3a, 5, 4a, 4b, 6a, 7, 6b, 8, 6c, 9, 10, 11, 11a, 12, 13, 13h, and 14.

TABLE 5. Dimensions of teeth from the Aurignacian levels of *Bacho Kiro*, relative to Neandertals and early modern humans¹

	Neandertals	Bacho Kiro	Early moderns
<i>I</i> ₁			
Mesiodistal length	6.0 ± 0.5 (10)	5.7	5.8 ± 0.7 (12)
Buccolingual breadth	7.4 ± 0.4 (14)	6.3	6.4 ± 0.4 (13)
Crown index	126.6 ± 11.4 (8)	110.5	111.9 ± 12.0 (12)
<i>I</i> ₂			
Mesiodistal length	6.8 ± 0.6 (18)	6.7	6.4 ± 0.7 (15)
Buccolingual breadth	8.0 ± 0.5 (20)	7.3	7.0 ± 0.6 (17)
Crown index	120.3 ± 9.8 (16)	109.0	108.8 ± 9.8 (15)
<i>dm</i> ₂			
Mesiodistal length	10.6 ± 0.6 (14)	(10.0)	10.6 ± 0.6 (6)
Buccolingual breadth	9.7 ± 0.5 (14)	(9.5)	9.4 ± 0.6 (6)
Computed crown area	102.7 ± 9.7 (14)	(95.0)	99.1 ± 11.2 (6)
Crown index	91.4 ± 4.9 (14)	(95.0)	88.8 ± 2.8 (6)
<i>M</i> ₁			
Mesiodistal length	11.7 ± 1.0 (31)	12.3	11.6 ± 0.9 (27)
Buccolingual breadth	11.1 ± 0.7 (32)	11.5	11.0 ± 0.6 (28)
Computed crown area	129.6 ± 15.8 (31)	141.5	127.1 ± 14.8 (27)
Crown index	95.7 ± 9.1 (31)	93.5	94.9 ± 6.1 (27)
<i>C</i> '			
Mesiodistal length	8.2 ± 0.6 (17)	8.5	8.1 ± 0.6 (11)
Buccolingual breadth	9.4 ± 0.6 (18)	9.3	9.0 ± 1.0 (11)
Computed crown area	76.5 ± 8.0 (17)	79.1	73.3 ± 13.1 (11)
Crown index	115.2 ± 12.6 (17)	109.4	112.0 ± 7.3 (11)
<i>P</i> ⁴			
Mesiodistal length	7.0 ± 0.6 (16)	7.9	7.1 ± 0.5 (13)
Buccolingual breadth	10.4 ± 0.8 (18)	10.2	9.7 ± 0.7 (15)
Computed crown area	72.8 ± 9.7 (16)	80.6	69.6 ± 9.7 (13)
Crown index	150.9 ± 14.3 (16)	129.1	137.4 ± 6.2 (13)

¹ Dimensions of *Bacho Kiro* teeth from Glen and Kaczanowski (1982); Neandertal and early modern human data from Frayer (1978). Computed crown area = mesiodistal length * buccolingual breadth. Crown index = 100 * buccolingual breadth/mesiodistal length.

the *Bacho Kiro* remains is apparent when one compares the size and shape of the four teeth from this level to those from samples of available Neandertal and early Upper Paleolithic (Aurignacian and Gravettian) modern human teeth (Table 5). Glen and Kaczanowski (1982) remarked merely that the *Bacho Kiro* dentition falls metrically between Neandertal and early modern human values, albeit somewhat closer to the former. They further note that the adult canine and fourth premolar are metrically most similar to the small sample of Neandertals they included in their comparative data. In terms of mesiodistal (MD) and buccolingual (BL) crown diameters, computed crown areas (MD * BL), and crown indices (100 * BL/MD), the *Bacho Kiro* *M*₁ and *C*¹ are indistinguishable from either the Neandertal or early modern human samples. The *Bacho Kiro* *P*⁴ is large relative to the means of both comparative samples, in large part due to its great MD diameter. The relatively great MD length of this premolar gives it a crown index that is well below the mean index values of both comparative groups

(1.3 standard deviations below the modern human mean, 1.5 standard deviations below the Neandertal mean). Thus the initial assessment by Glen and Kaczanowski (1982) of the *C*¹ and *P*⁴ similarities to Neandertal teeth does not hold when larger fossil samples are taken into consideration. Although values are given for the crown dimensions of the deciduous second molar, heavy occlusal wear precludes an accurate assessment of the size and shape of this tooth.

Unfortunately, the Aurignacian-associated teeth from *Bacho Kiro* preserve few diagnostic characteristics that would be helpful in determining their affinity. Most of the discrete traits that differentiate Neandertal from modern human teeth (see Table 13 in Bermúdez de Castro et al., 1999) are not of help in this case, since they involve either teeth not represented in the *Bacho Kiro* sample, or require adjacent pairs of teeth for examination of size sequences, or consist of crown features that do not unequivocally separate the groups. For example, the *Bacho Kiro* *M*₁ (from the 6a/7 contact) has a small but clearly developed

hypoconulid. According to Bermúdez de Castro et al. (1999, p. 557), in Neandertals the hypoconulid is reduced in size and/or incidentally absent in M_1 and M_2 , while in modern humans it is "frequently absent in M_2 and less so in M_1 ." Thus without trait frequencies based on large samples, it is impossible to evaluate the taxonomic relevance of this character. Taurodontism of the molar roots is one feature that could potentially be of benefit, but regrettably no radiographs of the Bacho Kiro M_1 have yet been published.

Our overall evaluation of the Bacho Kiro Aurignacian adult dental sample indicates that these teeth are largely ambiguous with respect to taxonomic characteristics, but that those few aspects of size, shape, and crown morphology that do distinguish them from one or the other of the comparative samples tend to align them with modern humans.

Hahnöfersand (Elbe Valley, Germany)

An isolated frontal bone, the Hahnöfersand specimen reflects a robust modern human in its vault and brow ridge architecture (Bräuer, 1980, 1981; Smith, 1984). As with other early modern Europeans, the Hahnöfersand frontal (Fig. 4) has well-developed superciliary arches with marked thinning laterally (Smith, 1984), and with separation of the superciliary arch and the supraorbital trigone (Bräuer, 1980). The Hahnöfersand fossil appears to have a rather low frontal angle ($60^\circ \pm 5^\circ$: Bräuer, 1980), but this angle is difficult to measure accurately on this specimen. Hahnöfersand also shares with later Upper Paleolithic crania from Paderborn and Oberkassel the presence of a small midsagittal ridge (Smith, 1984). Overall, Hahnöfersand is modern in morphology, but with some primitive or even Neandertal-reminiscent features (low frontal angle, prominent brow ridges, and large overall dimensions: Smith, 1984). The strength of these features is reflected in morphometric analyses that group Hahnöfersand either with Neandertals or in a position intermediate between Neandertals and early modern human crania (Bräuer, 1980, 1981).

Discovered in a sand deposit of the Elbe River near Hamburg in 1973, the Hahnöfer-

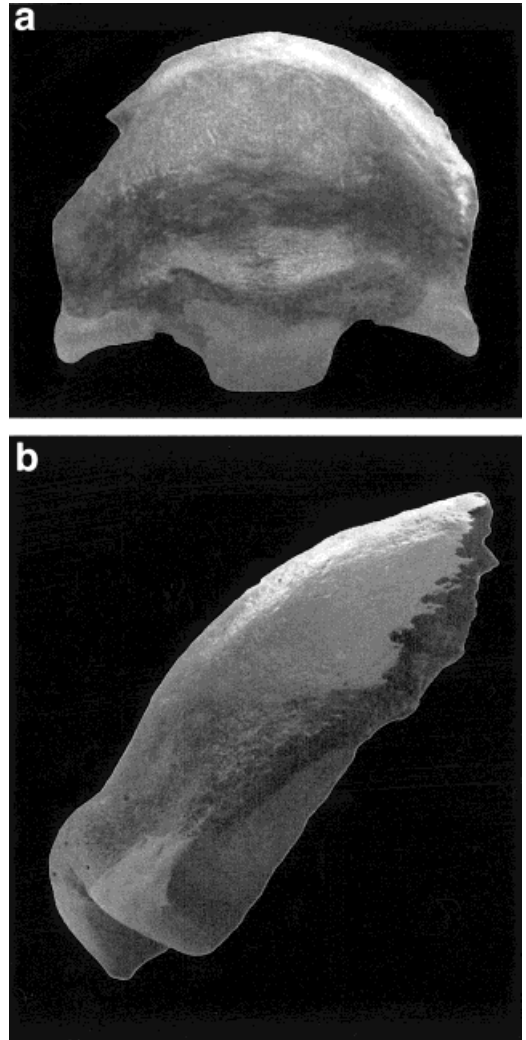


Fig. 4. Hahnöfersand frontal. **a:** Anterior. **b:** lateral.

sand frontal appears to have been secondarily deposited and has no archeological context. Both amino-acid racemization (AAR) and conventional radiocarbon dating of residual bone collagen give consistent absolute ages for Hahnöfersand at ca. 36 ky BP (AAR, 36 ky BP; ^{14}C , 36.3 ± 0.6 ky BP; Bräuer, 1980). If these dates can be accepted, this makes the Hahnöfersand frontal the earliest taxonomically diagnosable specimen of a modern human yet recovered in Europe. Hahnöfersand obviously does not help to clarify the issue of who made which lithic industry, but it does tell us, *if the AAR*

and ^{14}C dates are correct, that modern humans were installed in North-Central Europe by end-Hengelo times. Given the lack of a clear geological or archaeological context for this specimen, along with the recent successes of AMS dating, the time has probably come to redate this fossil.

Vogelherd (Swabian Jura, Germany)

Vogelherd Cave, near the town of Stetten, preserves 2–4 m of cultural deposits, extending from the early Mousterian to the Neolithic. After excavations in 1931, Gustav Riek identified what he believed to be three Aurignacian phases at Vogelherd Cave, which he designated lower, middle, and upper (Riek, 1934). Riek's "lower Aurignacian" was contained in horizon VI, and was represented by only a few stone and two bone tools. These bone tools are large bone points, which are also found in association with late Mousterian assemblages in some areas (Montet-White, 1996). This level also lacked mammoth ivory animal and anthropomorphic figurines like those recovered from the Aurignacian in higher levels. On reexamination of the material from this component, Müller-Beck (1983, p. 250–251) attributed the tools to the late Mousterian. Riek's "middle Aurignacian" from horizon V has likewise been redesignated as early Aurignacian (Müller-Beck, 1983). The typically Aurignacian tools and carvings derive from this layer, and from the late Aurignacian of horizon IV (Hahn, 1983).

Human skeletal elements from at least 3 adult individuals were recovered from levels V and IV (Gieseler, 1937, 1940, 1971; Czarnetzki, 1980, 1983; Smith, 1984). The first specimen, Vogelherd 1 (also known as Stetten 1), consists of a modern human cranium (lacking most of the face; Fig. 5) and a partial mandible (Fig. 6), found 0.15 m east of the cranium and 0.33 m deeper. Both were found in a "Brandschicht" or burned layer in horizon V in front of the southwest entrance (Riek, 1932, 1934). Two lumbar vertebrae, of identical color to the skull, were found 2–3 m east of the cranium in the same layer and were also attributed to Vogelherd 1 (Riek, 1932). Czarnetzki (1980) also mentions the presence of an undescribed second metacarpal, presumably

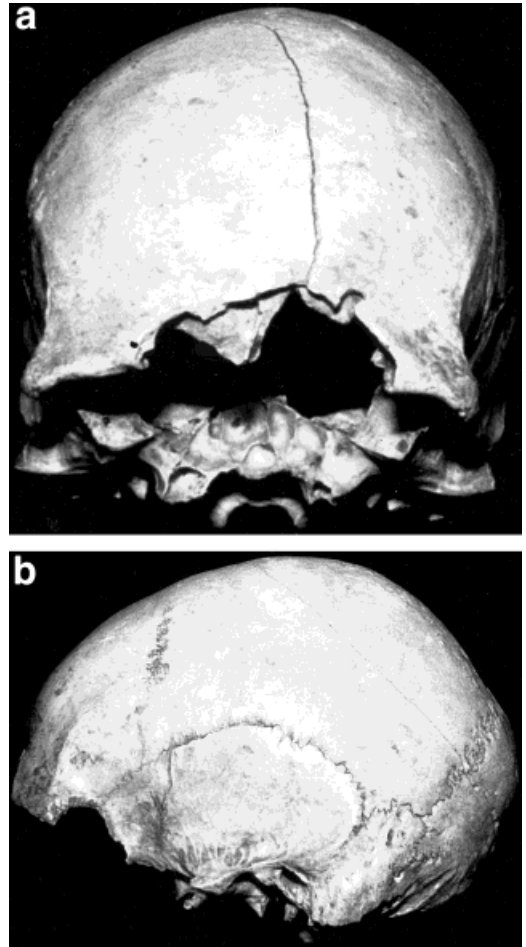


Fig. 5. Vogelherd 1 cranium. **a:** Anterior. **b:** Lateral.

from horizon V, which may belong to this individual. There is some confusion in the literature concerning where in horizon V the Vogelherd 1 remains were found. Gieseler (1937, p. 42) reported that the cranium and burned layer were located between the "middle and upper Aurignacian," which would place it at the top of horizon V. However, Riek (1934, p. 40–41), the cave's excavator, clearly describes and illustrates Vogelherd 1 and the burned layer to lie at the base of horizon V. Riek's placement of the specimen, based on his personal observation of the cave's stratigraphy, is likely to be sounder than Gieseler's, but either way there is little doubt that the specimen derived from the early Aurignacian component of Vogelherd.



Fig. 6. Vogelherd 1 mandible, lateral view.

The second individual, Vogelherd 2 (Stetten 2) (Fig. 7), was discovered just inside the south entrance, separated by the entire length of the cave from Vogelherd 1. According to Riek (1934), it was found at the top of the Upper Aurignacian layer (now level IV), and there were noncultural layers deposited above it in this area of the cave (a layer of fine splintered yellow-white limestone). While Riek (1934) pointed out that there was no mixing of this limestone layer with the Aurignacian layer in this area, Gieseler (1937) believed that Vogelherd 2 might have been deposited by later Magdalenian peoples.

The third individual, Vogelherd 3 (Stetten 3), consists of a robust right humerus (Fig. 8), lacking its proximal end. According to Gieseler (1937, p. 43), this specimen derived from near the middle of the cave at the base of the "middle Aurignacian" (now early Aurignacian, horizon V). Furthermore, Gieseler (1937) stated that the specimen was excavated partly from this level and partly from the underlying sterile layer comprised of large, coarse pieces of limestone rubble ("grobstückiger Kalkschutt"). According to Gieseler (1937, p. 43), "Riek assumes that, according to the profile, this humerus is probably somewhat older than the Stetten I skull."

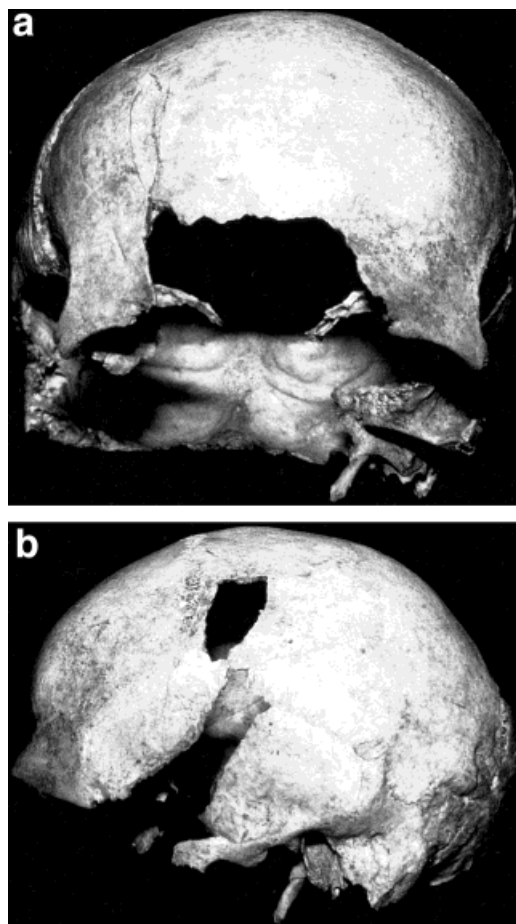


Fig. 7. Vogelherd 2 cranium. a: Anterior. b: Lateral.

Radiocarbon dates from horizons IV (30.73 ± 0.75 ky BP) and V (30.16 ± 1.34 and 31.9 ± 1.1 ky BP) indicate a late Interpleniglacial age for the Vogelherd Aurignacian (Müller-Beck, 1983). The ^{14}C determinations from Vogelherd horizon V provide a minimum age for the humerus, however, since it was recovered from the base of this horizon. Some finer chronological resolution can be had by considering dates from the Aurignacian levels at the German site of Geißenklösterle. Here a German "proto-Aurignacian" occurs in horizon IIIa, with a typical Aurignacian component in IIa–IIc (Hahn, 1983, 1996; but see Zilhão and d'Errico, 1999, concerning the possibility that Hahn's proto-Aurignacian is an IUP assemblage with cryoturbational mixing from Aurignacian levels). Climatic recon-

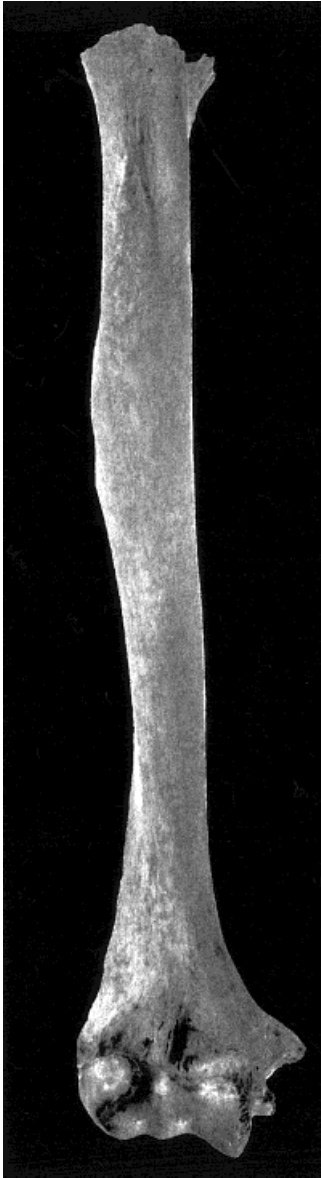


Fig. 8. Vogelherd 3 right humerus, anterior view.

struction suggests that Vogelherd horizon IV and Geißenklösterle horizons IIa and IIb correspond to cold-dry periods (likely Würm IIIa), while Vogelherd horizon V and Geißenklösterle horizons IIc and III correspond to cold-humid periods. The humid climatic conditions suggest a Würm II/III interstadial age (Hengelo temperate oscillation), which would be consistent with dates from

the proto-Aurignacian levels at Geißenklösterle. AMS radiocarbon dates from the base of Geißenklösterle (horizon III) range from 40.2 ± 1.6 to 37.3 ± 1.8 ky BP, with a central tendency of 38.4 ± 0.9 (Richter et al., 2000). Richter et al. (2000) also obtained six TL dates on burned flints from level IIIa, producing an average age of 40.2 ± 1.5 ky BP. Given the systematic underestimation of ^{14}C dates in this time range, the TL dates are concordant with the AMS determinations for the level. The taphonomic situation at Geißenklösterle is complex, as is the typological diagnosis of the artifact assemblage (see Zilhão and d'Errico, 1999). Obviously we need better chronological data from Vogelherd if we wish to place the human remains from that site in time. However, if Geißenklösterle level III corresponds to Vogelherd V (as suggested by climatic indicators and artifacts), then the Vogelherd humerus (found at the very base of horizon V) and the Vogelherd 1 cranium (also from the base of horizon V according to Riek, 1934) would date to the Würm II/III interstadial or early Würm IIIa times.

From a morphological standpoint, both Vogelherd crania unequivocally represent modern humans (Gieseler, 1937), albeit with some archaic features (Smith, 1984; Frayer et al., 1993). Both crania have high-domed vaults with steep frontal angles and exhibit a level of occipital bunning (slightly more pronounced in Vogelherd 1; Figs. 5, 7) characteristic of most early Upper Paleolithic crania. Both specimens also preserve the lateral portions of the supraorbital ridges, which are only moderately projecting and fall comfortably within the range of other early modern humans in both thickness and projection (Smith, 1984, p. 154). In rear view, both Vogelherd 1 and 2 have vertical sides and exhibit vault contours that generally resemble modern humans. However, both crania have their maximum breadths either low on the parietals (Vogelherd 2) or at the level of the supramastoid crest (Vogelherd 1). In these features the Vogelherd crania are similar to the male Mladeč 5 and 6 crania (Smith, 1984; Frayer, 1986). The Vogelherd 1 mandible (Fig. 6) has a well-developed chin with a distinct mental trigone. The mandible also exhibits

a retromolar space and a horizontal-oval configuration of the mandibular foramen, both of which are more characteristic of Neandertals than early modern humans (Smith 1984; Frayer et al., 1993).

The Vogelherd 3 humerus is robust and has large, rugose muscle markings. Gieseler (1937, 1940) stated that these features suggest Vogelherd 3 might represent a Neandertal and that its stratigraphic position supported that possibility. However, based on an analysis of humeral epiphyseal and diaphyseal shape and strength measures of Vogelherd 3 relative to humeri of Neandertals and early modern humans, Churchill and Smith (2000) concluded that the specimen derived from an anatomically modern human. The Vogelherd humerus shares with other early modern human humeri (and differs from Neandertals) in having a wide deltoid tuberosity with three crests, an expanded ("nonstenotic") diaphyseal cross section, and a mediolaterally narrow olecranon fossa bounded by relatively thick distodorsal pillars (Churchill and Smith, 2000). The most striking feature of the Vogelherd 3 humerus is its large, rugose, and projecting deltoid tuberosity. The overall stoutness and rugose muscle scarring of this specimen were what led to initial claims that it may represent a Neandertal, and undoubtedly the enlarged, rugged deltoid tuberosity must have contributed to this impression. Ironically, it is the morphology of the deltoid tuberosity that most clearly distinguishes the Vogelherd 3 humerus from that of Neandertals. In its absolute and relative width, and in its crest configurations, the deltoid tuberosity of Vogelherd 3 is most similar to that of early modern humans from later Aurignacian and Gravettian contexts.

The Vogelherd humerus evidently derived from a robust, muscular individual, yet there is nothing that clearly indicates the retention of Neandertal features. In this respect the Vogelherd humerus is similar to the postcranial material recovered from Aurignacian contexts at Mladeč Cave (Czech Republic) (Smith et al., 1989b). Like Vogelherd 3, some aspects of the Mladeč postcranial material evince skeletal hypertrophy (most notably, the size of the joint

surfaces: Wolpoff, 1992), but the overall morphology is unequivocally more modern than archaic. This includes nonstenotic long-bone diaphyses with reduced cortical thickness, and the clear absence of typical Neandertal features (such as narrow humeral deltoid tuberosities, medially oriented radial tuberosities, and absence of femoral pilasters) (Smith et al., 1989b). At both Mladeč and Vogelherd, possibly Neandertal-reminiscent features are more readily identifiable in the cranial than postcranial material (see Smith et al., 1989b; Frayer, 1992; Wolpoff, 1992; Frayer et al., 1993).

Riparo Bombrini (Liguria, Italy)

Excavations in 1976 resulted in the recovery of an isolated human tooth—a deciduous left lateral mandibular incisor (Li_2)—in level III of Riparo Bombrini. Situated atop a level (IV) containing tools characteristic of a late denticulate Mousterian (Vicino, 1986), level III appears to represent the base of an early Aurignacian sequence (extending upwards through level I) characterized by Dufour bladelets, bone points, decorated bones, perforated shells, and lumps of red ochre (Vicino, 1986). Gioia (1990) puts the Aurignacian at Riparo Bombrini between 33.0–31.5 ky BP, in the dry/cold interval of Würm IIIa. However, a very similar early Aurignacian assemblage with Dufour bladelets at nearby Riparo Mochi dates between 34.5–33.0 ky BP (Gioia, 1990). If the two assemblages are contemporaneous, the human milk tooth may date to the period of climatic instability at the beginning of Würm IIIa.

According to Formicola (1989), the tooth is small in both mesiodistal and buccolingual dimensions compared to both Neandertals ($n = 2$) and a combined sample of Mesolithic and late Upper Paleolithic specimens. He also notes that the tooth does not appear to have the Neandertal characteristic of a pointed incisal edge, and judging from drawings of the specimen (Formicola, 1989, p. 288), the preserved root does not exhibit mesiodistal broadening and buccolingual flattening as one would expect in a Neandertal. This incisor likely derives from a modern human.

It should be noted that new dating and stratigraphic reanalysis of possibly Aurignacian-aged human remains from Grimaldi (at Grotte des Enfants, Barma Grande, and Baouso da Torre) revealed these remains to most likely derive from Gravettian or later periods (Mussi, 1986; Bisson et al., 1996).

La Ferrassie (Dordogne, France)

A single human left I¹ from level E' of La Ferrassie was discovered in the collections of the Musée National de Préhistoire des Eyzies (Gambier et al., 1990). The artifacts from this level were considered to represent an early ("ancient") Aurignacian by De Sonneville Bordes (1960), and this makes the La Ferrassie tooth the only specimen to derive from the basal Aurignacian in France. The level is also thought by Leroyer (1988), on palynological and sedimentological grounds, to have been deposited during the cold episode of Würm IIIa, just prior to the Denekamp temperate oscillation, ca. 34–32 ky BP.

According to Gambier et al. (1990), the tooth is not shovel-shaped (although strong marginal ridges can be seen in the accompanying photograph), and morphologically and metrically it falls closest to samples of fossil modern humans. They are careful to note, however, that the tooth could also fit comfortably within a sample of Neanderthals, and that a definitive classification of the specimen is not possible.

Vindija Cave (Hrvatsko Zagorje, Croatia)

During the course of excavations between 1974–1986, Mirko Malez and collaborators recovered more than 100 hominid fossils from three stratigraphic levels at Vindija Cave (Malez et al., 1980; Smith and Ahern, 1994) (Fig. 9). Level D, the stratigraphically highest level with hominid remains, has produced 45 anatomically modern specimens (Malez et al., 1980; Smith et al., 1985) in association with artifacts typical of the final Gravettian (Karavanić, 1995), and likely deposited at the end of Würm III (Malez and Rukavina, 1979). Level G₃, the stratigraphically lowest level to produce hominid remains, yielded 48 specimens in association with Mousterian artifacts (Malez et al., 1980; Smith et al., 1985). This

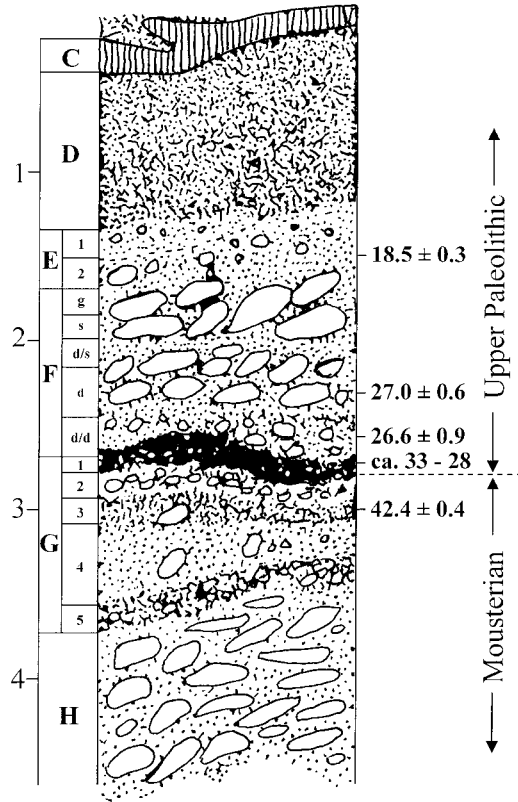


Fig. 9. Generalized stratigraphic section of Vindija Cave, redrawn with modifications from Karavanić (1995). The left-hand scale represents meters below the surface. The right-hand column indicates radiometric dates (in uncalibrated radiocarbon years) for the G₃, G₁, F_{d/a}, F_d, and E levels (from bottom to top). Dates from Karavanić (1995) and Smith et al. (1999).

layer is provisionally dated to the end of the lower Würm stadial (end Würm II: Wolpoff et al., 1981; Karavanić and Smith, 1998). The human remains from G₃ are diagnostically Neandertal, but exhibit a mosaic of Neandertal and modern human features, indicating either a parallel evolution of modern human morphological traits in late Neandertals or significant flow of modern human genes into the Hrvatsko Zagorje Neandertal population (see Wolpoff et al., 1981; Smith, 1994 and references therein).

Between Vindija's layers D and G₃ lie the earliest Upper Paleolithic strata: G₁, F_{d/a}, and F_d. G₁ is a thin but distinctive level dating toward the end of the Interpleniglacial (Rukavina, 1983) that has produced only a small sample of typologically diag-

nostic lithic pieces (15 out of 62 total lithics recovered). Six of these are typologically Upper Paleolithic (including two end-scrapers on flakes and one on an Aurignacian blade, a straight dihedral burin, a blade with two continuously retouched edges, and a leaf-shaped bifacial piece), while nine are more typical of the Mousterian (five side-scrapers and four denticulates) (Karavanić, 1995; Karavanić and Smith, 1998). This layer has also produced a split-base bone point characteristic of the Aurignacian, and two massive-base bone points, as well as fragments of others (Karavanić, 1995). Massive-base bone points are found in early Upper Paleolithic, and also probably late Mousterian (Montet-White, 1996), components throughout Central Europe. The interface between the G and F layers and the lower part of the F layer have produced a larger lithic sample, but one that is again characterized by a combination of Upper Paleolithic-type tools (including some type-fossils of the Aurignacian: Aurignacian blades, and keeled and nosed end-scrapers) and Middle Paleolithic elements (notched pieces, denticulates, and side-scrapers) (Karavanić, 1995; Miracle, 1998). Radiocarbon dating of cave bear bones at the base of the F layer (level F_{d/a}) indicates an age of 26.7 ± 0.9 ky BP, while a sample of charcoal found near the interface of the two lowest strata in the F level (F_d/F_{d/a}) produced a radiocarbon date of 27.0 ± 0.6 ky BP (see Karavanić, 1995).

The typological attributes of the G₁ and lower-F (F_{d/a} and F_d) assemblages, comprising as they do both Middle and Upper Paleolithic elements, are a matter of ongoing debate. The occurrence of Aurignacian-type tools (including the *fossile directeur* of the Aurignacian I—the split-base bone point; Bordes, 1968) certainly lends an Aurignacian flavor to the assemblages, and any diagnosis that relied on index fossils would undoubtedly classify them as early Aurignacian (see Karavanić, 1995). However, Aurignacian type-fossils, including split-base bone points, occur with regularity in IUP assemblages (such as in the Szeletian at Szeleta Cave [level 4] and Dzeravá Skála [levels 5–11]; Miracle, 1998), as well in assemblages that are lithically undiagnostic (Miracle, 1998). Clearly the utility of these

artifacts as *fossiles directeurs* for the Aurignacian of East-Central Europe has not been established (Karavanić and Smith, 1998). When frequencies of retouched lithics are examined, the assemblage from Vindija G₁–F_d does not compare favorably to those from other European Aurignacian levels (Miracle, 1998). At present it is uncertain whether the Vindija G₁ assemblage represents an early Aurignacian comparable to that found elsewhere in Europe (although this possibility appears increasingly doubtful), a Central European regional variant of the Aurignacian (“Olschewian,” as in Karavanić and Smith, 1998), a Szeletian component (Miracle, 1998), or a late Mousterian that incorporates Aurignacian tools obtained through contact with (possibly) contemporaneous Upper Paleolithic peoples living at nearby sites like Velika Pećina.

The F complex, specifically levels F_d and F_{d/a}, is likely a separate time component from level G₁. This is supported by the distinctly different color and lithology of the sediments, with the F complex comprising sandy sediment with abundant stone rubble, while G₁ is a distinctive reddish clay (Malez and Rukavina, 1979). Furthermore, the chronometric dates for G₁ and the F complex (see below) suggest a temporal separation, and the lithics in the F complex are more clearly and consistently Upper Paleolithic in character (Karavanić, 1995).

Six fragmentary human fossils have been recovered from the G₁ layer at Vindija. These remains include the right ramus and posterior corpus (sans teeth) of a mandible (Fig. 10), a fragment of a left parietal, a left zygomatic (Fig. 11), a left frontal fragment (preserving the medial portion of the supraorbital torus; Fig. 12), and two isolated right maxillary teeth (I¹ and C¹) (Wolpoff et al., 1981; Smith and Ahern, 1994). A number of morphological features indicate that these remains can be confidently classified as Neandertal. The diagnostic Neandertal features in the G₁ fossils include a retromolar space, horizontal-oval mandibular foramen and a medial pterygoid tubercle on the mandibular fragment, a prominent Bresschet's sulcus on the parietal fragment, marked shoveling and large size of the maxillary incisor, a columnar frontal process

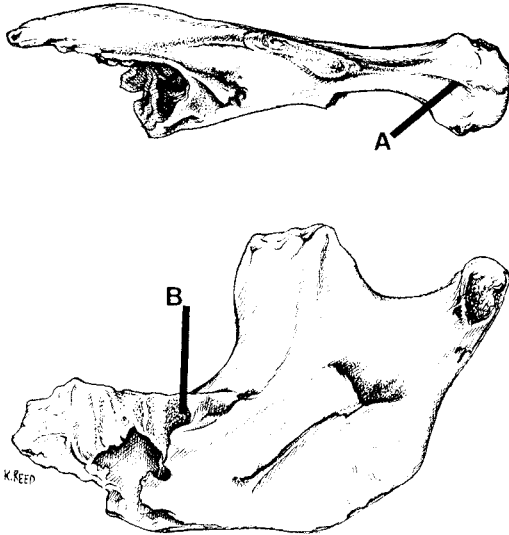


Fig. 10. Vindija 207 mandible in occlusal (top) and medial (bottom) views. Note the retromolar space between the alveolus for M_3 (B) and the anterior border of the ramus, the horizontal-oval mandibular foramen, and the medial position of the intersection between the mandibular notch (incisura) and the condyle (A). Drawing by Kim Reed, reprinted from Karavanić and Smith (1998).

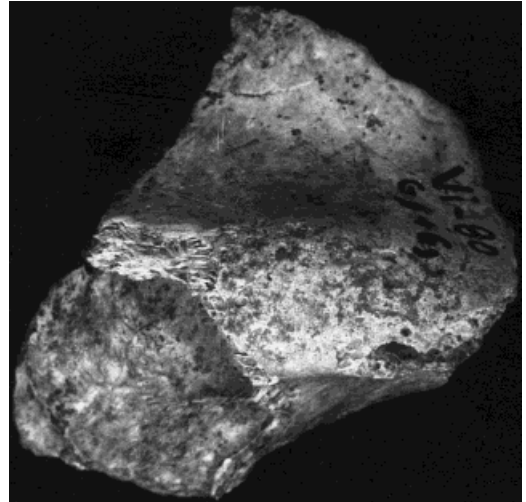


Fig. 12. Vindija 308 left frontal fragment, anterior view.

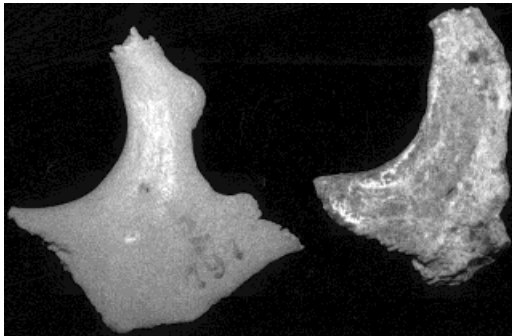


Fig. 11. Vindija 307 (right) and modern human (left) left zygoma in lateral view. Note the columnar frontal process in the Vindija specimen.

and multiple zygomaticofacial foramina on the zygomatic, and a large frontal sinus restricted within a true supraorbital torus in the frontal fragment (Wolpoff et al., 1981; Smith and Ahern, 1994).

Five human fossils were recovered from the base of the F complex: three isolated permanent teeth from level F_d (a right I^2 , a right I_2 , and a left C_1), and two parietal fragments that articulate along the sagittal suture, from $F_d/F_{d/d}$ (Wolpoff et al., 1981;

Smith et al., 1985; Smith and Ahern, 1994). The maxillary incisor is markedly shoveled (the primitive condition for the genus *Homo*, which occurs in some modern humans as well), and both incisors are similar to those of Neandertals in being buccolingually thick relative to the crown mesiodistal diameter (see Table 6 in Wolpoff et al., 1981). However, these dimensions lie within or just slightly above the ranges for early Upper Paleolithic specimens in Smith (1984, p. 150–151). Furthermore, the most diagnostic specimen (the conjoining right and left parietal fragments) exhibits a more modern, gabled contour to the cranial vault, and there is an indication of lambdoidal flattening comparable to that seen in Central European early modern human crania (Smith et al., 1985). Although the small size and fragmentary nature of this sample preclude staunch interpretations of the nature and affinities of the F complex human sample, the most reasonable working hypothesis is that these people were fundamentally modern, with some Neandertal reminiscent features.

The significance of the association of Neandertal fossils with an Aurignacian-like assemblage in Vindija G_1 remains uncertain. Imprecise stratigraphic control during excavation, along with evidence of cryoturbational and bioturbational disturbance of

some of the sediments, have plagued efforts to interpret the G_1 artifact assemblage and fossil humans (see Karavanić, 1995; Miracle, 1998; Zilhão and d'Errico, 1999). Frost heave or sediment disturbance by denning cave bears could have mixed lithic and osseous materials in G_1 from lower Mousterian (G_3 and G_2) and higher Aurignacian (F) horizons (Kozłowski, 1996; Montet-White, 1996; Karavanić and Smith, 1998; Zilhão and d'Errico, 1999). Inexact excavation records make establishing the provenience of some of the G_1 artifacts difficult, and some of them do appear to derive from the cryoturbated portion of the sediments (Karavanić and Smith, 1998). Karavanić and Smith (1998) noted, however, that the G_1 mandibular fragment and the split-base bone point derive from a portion of the cave in which sediments are undisturbed, and that the Upper Paleolithic lithic and osseous tool types lack modifications characteristic of postdepositional movement (such as nibbling and edge rounding; see also Miracle, 1998 for further support for a reliable association of Neandertal remains with Upper Paleolithic tools).

Attempts to radiometrically date the G_1 materials have clarified but not resolved the issue. Karavanić et al. (1998) attempted to directly test the contemporaneity of the hominids and artifacts in G_1 through gamma-ray spectrometry of the mandibular fragment and the split-base bone point. Results indicated ages of 51.0 ± 8.0 and 46.0 ± 7.0 ky BP (U-Th and U-Pa, respectively) for the mandible, and 45.0 ± 6.0 (U-Th) and 30.0 ± 5.0 ky BP (U-Pa) for the bone point (Karavanić et al., 1998). The determinations on the mandible are considerably older than a previous AMS date on a fragment of cave bear (*Ursus spelaeus*) bone of 33.0 ± 0.4 ky BP (Karavanić, 1995), which may be seen as support of the claim of stratigraphic mixing in G_1 , except that the inconsistent dates obtained on the bone point and the relatively high error ranges may also reflect the unreliability of gamma-ray dating. More recently, Smith et al. (1999) attempted to date two artifacts (including the split-base bone point) and two hominid fossils (the mandibular and parietal fragments) from G_1 by AMS radiocarbon. Unfortunately, both bone

points lacked sufficient collagen and/or suffered from contamination, and failed to produce reliable dates. The mandibular fragment produced an uncalibrated date of 29.1 ± 0.4 ky BP, while the parietal fragment was dated to 28.0 ± 0.4 ky BP (Smith et al., 1999). While these two dates are not statistically significantly different from one another, they are significantly younger than the date obtained on the cave bear bone, and indicate a minimum span of 3,000 years in the formation of layer G_1 .

The young dates derived from the G_1 hominid material deserve discussion. In addition to demonstrating a Neandertal presence in Central Europe until well into the Upper Pleniglacial (several thousands of years after unequivocally modern humans had appeared in Europe), the young ages also make unlikely the possibility that they were secondarily deposited in G_1 from lower levels by cryo- or bioturbation. Unfortunately, the only date in existence for Vindija G_3 is a questionable amino-acid racemization (Isoleucine) determination of 42.2 ± 4.3 ky BP (Smith et al., 1985). Dates for the F_d and $F_{d/d}$ levels fall at the very end of the Aurignacian range and overlap with the range for the younger Gravettian in this part of Europe (Karavanić, 1995).

Mladeč (Moravian karst, Czech Republic)

The Mladeč Caves have produced perhaps the largest, most important, and best-studied assemblage of early modern human skeletal material associated with the Aurignacian. The morphological attributes and taxonomic affinities of the cranial material, and to a lesser extent postcranial material, have been well described (Szombathy, 1925; Smith, 1982, 1984; Jelínek, 1983; Frayer, 1986; see especially a new and detailed analysis by Frayer et al., nd), and we provide only a brief summary of that work here, choosing instead to focus on the archeological and geochronological context of the material.

The Mladeč Caves (also known by the German name Lautsch) comprise a main cave system (variously known as Fürst-Johanns-Höhle or Bacova díra) and a smaller side cave (known as the Quarry Cave or



Fig. 13. Mladeč 1 female cranium in oblique view.

simply the Side Cave) 50 m to the west of the main site (Smith, 1997). The main cave was excavated under the direction of Josef Szombathy in 1881 and 1882, and later by Jan Knies (in 1903), Jan Smyčka (in 1912), and Johann Fürst (in 1922), while the Quarry Cave was excavated in 1904 by Jan Knies (Smith, 1997). These excavations produced 101 identifiable human fossil specimens, including two largely complete young adult female crania and two calottes with possibly associated mandibles representing adult males (sadly, 59 of these specimens were destroyed, along with the entire inventory of human remains from Predmostí and numerous specimens from Dolní Věstonice, by a fire in Mikulov Castle in the closing days of World War II). There is widespread agreement that these remains represent a population of early modern humans, although disagreement exists as to their degree of Neandertal affinity (see, e.g., Frayer, 1986; Frayer et al., nd, vs. Bräuer and Broeg, 1998). As with other early modern human crania from this region, the crania from Mladeč (Figs. 13, 14) are characterized by marked development of the brow ridges (in the male crania), long cranial vaults, lambdoidal flattening, occipital bunning, and robust nuchal areas (Smith, 1984). Sev-

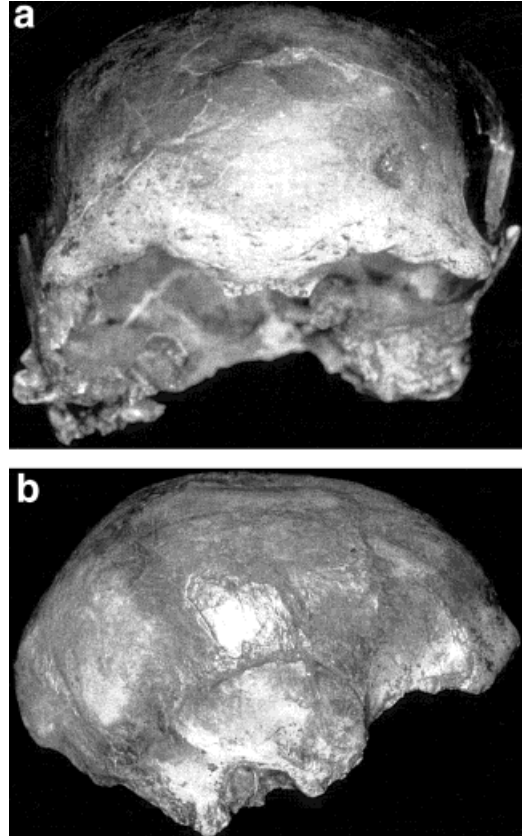


Fig. 14. Mladeč 5 male cranium. a: Anterior. b: Lateral.

eral of the specimens have been further argued to exhibit traits considered by some to be uniquely derived for Neandertals, including an elliptical suprainiac fossa, extensive lambdoidal flattening, and a short posterior occipital face in Mladeč 6, a Neandertal-like cranial vault form in lateral view coupled with a marked occipitomastoid crest, small mastoids, and midfacial prognathism in Mladeč 5, and a groove on the internal surface of the inferior nasal margin and a medial projection on the lateral internal wall of the piriform aperture in Mladeč 8 (Frayer et al., nd).

Among early modern human remains from Europe, the occipital morphology of the Mladeč males is the closest to the Neandertal condition. Both Mladeč 5 and 6 exhibit occipital bunning that extends more laterally than is typical for most early modern Europeans. The fact that variation in the

nature of occipital bunning is continuous in late Pleistocene Europeans suggests that the factors underlying bunning are not qualitatively different in early modern Europeans compared to Neandertals, and this underscores a Neandertal contribution to the early modern European gene pool. On the other hand, the bunning in Mladeč and other early moderns occurs in cranial vaults that are quite different in overall shape from Neandertals (see also Lieberman et al., 2000). For example, although both Mladeč 5 and 6 have broad cranial bases, both specimens lack the characteristic oval (“en bombe”) shape characteristic of Neandertals in rear view. Indeed, the parietal bosses in both Mladeč specimens are located high on the sides of the cranial vault. This places the bunning in the context of a rather different cranial shape in Mladeč and other early modern Europeans compared to Neandertals.

If the morphology of the entire Mladeč sample is considered, a number of important points emerge. The adult female crania (Mladeč 1 and 2) exhibit evidence of bunning and upper midfacial prognathism but otherwise have vault and facial forms that are not typical of Neandertals. These include their lateral and posterior vault contours, the presence of canine fossae and angled inferior zygomaticoalveolar margins, mastoid morphology, and the anatomy of their supraorbital regions. Furthermore, the mandibles pictured by Szombathy (1925), which were destroyed at Mikulov, appear modern in form, especially at the symphysis; and the postcranial remains, although not as extensively studied as the crania, are variable in size and robustness but are fundamentally modern in anatomical form (Smith et al., 1989b). Thus, when the entire sample is considered, the Neandertal reminiscent morphology at Mladeč is primarily found in what might be called “details” of anatomy rather than in the fundamental morphological gestalt. Such Neandertal similarities are certainly more evident in the male crania, as was recently detailed by Frayer et al. (nd), but even these specimens are clearly distinguishable

from Neandertals in overall morphological form.

In both the main and side caves, the human remains, artifacts, and faunal remains were collected from a reddish-brown clayey sediment that represents the fan of a talus cone formed by infilling through a chimney. As with the site of Zlatý kůň (below), there are no hominid occupation levels in the Mladeč Caves, and the remains in the caves were probably deposited through chimneys in the caves’ roofs, similar to the better-documented situation at Zlatý kůň (Svoboda, 2000). However, a small sample of artifacts have been recovered from the sediments (including > 22 bone points and 24 perforated animal teeth, but only a small collection of lithics; Frayer et al., nd). In the sediments of both caves, the bone points are flat with broad bases (the so-called Mladeč-type point), an artifact that tends to occur in early Aurignacian assemblages in Central Europe (Frayer et al., nd), although it is not restricted to such components (Montet-White, 1996). Split-base bone points, another common occurrence in the Moravian Aurignacian, are absent in the Mladeč deposits. Bone awls (some 15 fragments) showing characteristic Aurignacian patterns of boneworking were also recovered at Mladeč (Frayer et al., nd). On the basis of the stratigraphy of the main cave, Szombathy (1925) thought the sediments to have accumulated in a short time. The homogeneity of the artifact assemblages at each site further suggests rapid accumulation, while the near identity of the artifacts and fauna from the main and side caves suggests that the two infillings were penecontemporaneous (Frayer et al., nd). Thus, according to Frayer et al. (nd), Mladeč can reasonably be considered a single component site (but see Svoboda, 2000). The relatively abundant Mladeč points and other bone tools suggest an early or middle Aurignacian association for the Mladeč early modern humans, and the associated fauna indicate relatively temperate (perhaps Denekamp) conditions (Frayer et al., nd).

Zlatý kůň (Bohemian karst, Czech Republic)

Koněprus Cave, situated on Zlatý kůň Hill a half-kilometer from the village of Koněprusy, was discovered during blasting operations in a limestone quarry in 1950 (Vlček, 1996; Svoboda, 2000). The cave produced a partial skeleton of a robust yet morphologically modern individual (an adult female according to Vlček, 1996),⁷ as well as artifacts of an Upper Paleolithic character, distributed within a large talus cone in the main chamber. The deposits in Koněprusy accumulated as debris fell through a chimney in the cave during early Upper Pleniglacial times (early Würm IIIb) (Prošek et al., 1952; Vlček, 1957; Svoboda, 2000). Some of the human material (the facial skeleton) exhibits gnawing from carnivores (Vlček, 1996). As there is no evidence that humans ever occupied the cave, the associations between the hominid fossils and cultural materials remains tentative, although Vlček (1996) notes that some of the artifacts were found concentrated in a restricted area near the skeleton, and may represent the contents of a satchel in the person's possession at the time of death. Artifacts recovered from Koněprusy have been described as representing an "Upper Paleolithic industry of Mousterian character" (Vlček, 1967, p. 268), as possibly having affinities with the local Szeletian (Prošek et al., 1952), or as Aurignacian on the basis of the presence of a fragmentary flat Mladeč bone point (Fridrich and Sklenár, 1976), which are characteristic of the early Aurignacian of South-Central Europe (Jelínek, 1978). Again, we hasten to point out that the use of type-fossils for classifying artifact assemblages is fraught with problems (see Miracle, 1998), and in any case the hominid remains and artifacts are not in clear association at Zlatý kůň. Efforts are currently underway (by P. Pettitt and E. Trinkaus) to derive direct dates on this important specimen.

⁷The posterior cranial vault and right zygomatic of Zlatý kůň were initially thought to represent one individual (Zlatý kůň 1), while the frontal, mandible, and isolated postcranial elements were thought to represent a second individual (Zlatý kůň 2). The cranial elements were later found to refit, and all of the material is now considered to represent a single individual.

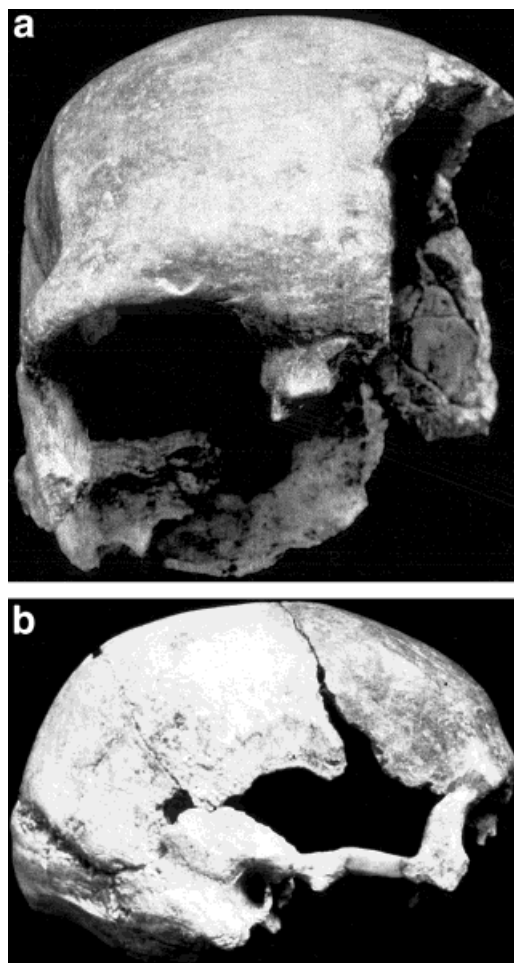


Fig. 15. Zlatý kůň cranium. a: Anterior. b: Lateral.

While the geological age and cultural associations of the Zlatý kůň hominid are not entirely certain, the morphological affinities of this specimen are quite clear. The skeleton preserves most of the neurocranium (lacking most of the basicranium; Fig. 15), including the supraorbital tori, both zygomatics, the right maxilla with C¹-M², the mandible with right C₁-M₂ and left I₂-M₂, five fragmentary vertebrae, and three rib fragments (Smith, 1982). The Zlatý kůň cranium is similar to other early modern Europeans (and different from Neandertals) in having well-developed occipital bunning, a robust supraorbital region divided into a superciliary arch and supraorbital trigone, an "en maison" vault contour in coronal profile,

zygoma without columnar frontal processes, and a maxilla with a narrow nasal aperture and a clear although weakly expressed canine fossa. The specimen also preserves a robust mandible with a distinct mental eminence and mental trigone, a moderately retreating symphysis (symphyseal angle = 81° ; average of 6 early Upper Paleolithic specimens = $76.8^\circ \pm 6.5^\circ$; 11 Neandertals, $98.5^\circ \pm 4.8^\circ$; Smith 1984, p. 161), and no retromolar space (Smith, 1982; Bräuer and Broeg, 1998). The preserved teeth are small, even relative to early Upper Paleolithic specimens (Smith, 1982). Although the specimen does exhibit a weakly developed suprainiac fossa on the occipital, the modern morphology of Zlatý kůň is indisputable.

Fossellone (Latium, Italy)

Excavations in 1953 by A.C. Blanc and others resulted in the recovery of human material from both Mousterian and early Upper Paleolithic levels at Fossellone, one of the many caves of Monte Circeo (Mallegni and Segre-Naldini, 1992; Mallegni, 1992). A fragment of the symphyseal region of a mandible, and three isolated teeth (left P_4 , M_1 , and M_2), likely all deriving from a single individual (Fossellone 3) about 9 years of age at death, were found in close association at the top of an undated level containing hyena teeth and coprolites and a small number of Mousterian tools. The remains were attributed by Mallegni (1992) to Neandertals on the basis of 1) similarities in the morphology of the lingual surface of the symphysis (namely, the presence of a median sagittal crest bounded by shallow depressions) to that of Guattari 2, 2) a sulcal (closed sulcus) and cusp (with incipient formation of an entoconid along with the protoconid and metaconid) pattern on the P_4 similar to that seen in Ehringsdorf and Le Moustier, 3) the presence of archaic features including cingula, fovea anterior, tubercle, and sulcal patterns, and 4) $M_2 > M_1$ in mesiodistal and buccolingual diameters and crown area. Mallegni (1992) notes, however, that the Fossellone 3 teeth are smaller in diameters and areas (and often more than one standard deviation below the mean) than those of other Neandertals, and in fact the sizes of these teeth generally fall within

one standard deviation of the means for Upper Paleolithic modern human teeth presented by Mallegni and Segre-Naldini (1992).

Of more relevance to this review are two fossils that were recovered from Upper Paleolithic contexts. Fossellone 1 is a right maxillary fragment with the M^1 and M^2 in place. This specimen was recovered from an Aurignacian level (level E) that represented a late stage of the early Aurignacian to La Place (1964, 1966) or Aurignacian 1 to Zampetti and Mussi (1988). Based on faunal attributes, this layer accumulated during the cold-dry interval of Würm IIIa about 33.0–31.5 ky BP (Zampetti and Mussi, 1988; Gioia, 1990).

Fossellone 1 preserves the entire P^4 and distal P^3 alveolar sockets, with a concavity of the buccal wall between them indicating a deep canine fossa (Mallegni and Segre-Naldini, 1992). The M^2 exhibits a small cingulum, and in size and shape the molars are similar to those of other Italian Upper Paleolithic modern humans (Mallegni and Segre-Naldini, 1992).

Fossellone 2 is a partial left scapula, preserving the glenoid fossa, most of the spine and acromial process, most of the coracoid process, and the proximal third of the axillary border. This specimen was recovered from an infilled erosion channel containing both Mousterian and Aurignacian tools, and thus the chronostratigraphic position of the fossil is uncertain. The overall morphology of this specimen is modern: the glenoid fossa is relatively wide, and the axillary border is bisulcate and dorsoventrally thin (Mallegni and Segre-Naldini, 1992). Since no diagnostic Gravettian tools were found in the channel fill, the erosion is thought to have occurred during a marine transgression at the end of the early Aurignacian occupation of the site, perhaps reflecting temperate conditions of the Denekamp interstadial or early Würm IIIb. Accordingly the scapula most likely represents a modern human associated with the Aurignacian at the site.

Kelsterbach (Frankfurt, Germany)

From a gravel pit near Frankfurt, Kelsterbach is a gracile calvarium (lacking much of its base; Fig. 16) of a modern human

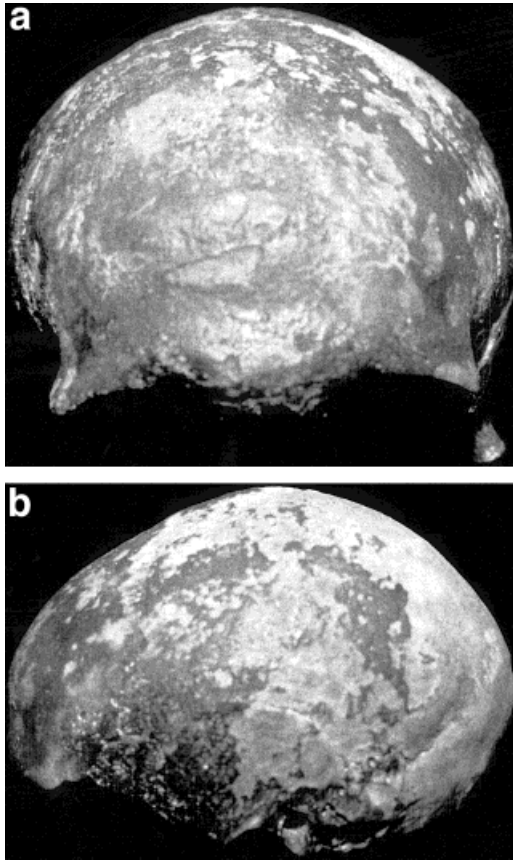


Fig. 16. Kelsterbach cranium. a: Anterior. b: Lateral.

female. Although the stratigraphic position of the specimen was noted in graphs and drawings by workmen (Protsch von Zieten, 1988), the age of the deposits has not been firmly established. The detailed recovery notes (from 1952), along with adherent matrix in the left auditory meatus and examination of the still-undisturbed stratigraphic section, allowed Protsch von Zieten (1988) and Protsch and Semmel (1978) to place the find in the lower part of a gravel bed at the "Obere Niederterrasse" or $t_{(6)}$ terrace of the river Main (Protsch von Zieten, 1988). Amino-acid racemization and radiocarbon dating of bone collagen have both been applied directly to the calvarium, with resulting age estimates of 32–31 ky BP (AAR, 32 ky BP; ^{14}C , 31.2 ± 1.6 ky BP; Protsch and Semmel, 1978), and if these ages are correct this would place the specimen in the period of

the later Aurignacian in this area. The specimen is remarkable, given its purported age, for its gracility and lack of archaic features: the brow ridges are weakly developed, the frontal angle is high, and there is only a slight indication of occipital bunning (Bräuer, 1980; Smith, 1984). As there is no archeological context for the specimen, Kelsterbach would seem another excellent candidate for AMS dating.

Kent's Cavern (Devonshire, England)

A right maxillary fragment (Kent's Cavern 4), preserving the canine, fourth premolar, and first molar (all heavily worn), was discovered stratigraphically below Aurignacian artifacts during excavations by A.H. Ogilvie in 1927 in trench C in the cave's vestibule (Oakley et al., 1971; Hedges et al., 1989). The "Aurignacoid" artifacts (Garrod, 1926) consist of several blades struck from opposed-platform cores (Hedges et al., 1989), which appear to represent the Upper Paleolithic but which are insufficient for cultural diagnosis. The hominid specimen was attributed to *Homo sapiens sapiens* by Keith (1927), and has since been dated by AMS radiocarbon to 30.9 ± 0.9 ky BP (Hedges et al., 1989). Layer A2, from which both the hominid maxilla and the early Upper Paleolithic tools derive (Keith, 1927; Campbell and Sampson, 1971), was subsequently recognized as a debris flow (see Aldhouse-Green and Pettitt, 1998), which complicates the chronostratigraphic picture somewhat.

A presumed Aurignacian-associated human skeleton was also recovered from the British site of Goat's Hole (Paviland). The ochre-stained partial skeleton of an adult male was recovered from this site in 1823 by the Rev. William Buckland (Aldhouse-Green and Pettitt, 1998). The presence of busked burins and nosed and carinated scrapers in the deposits at Paviland, and the apparent association of ivory bracelets and rods with the ochre-stained interment, led to the suggestion that the skeleton was of Aurignacian age, likely corresponding to the Aurignacian II of western continental Europe (Sollas, 1913; Jacobi, 1980; see also Aldhouse-Green and Pettitt, 1998). Subsequent direct dating of the Paviland 1 skele-

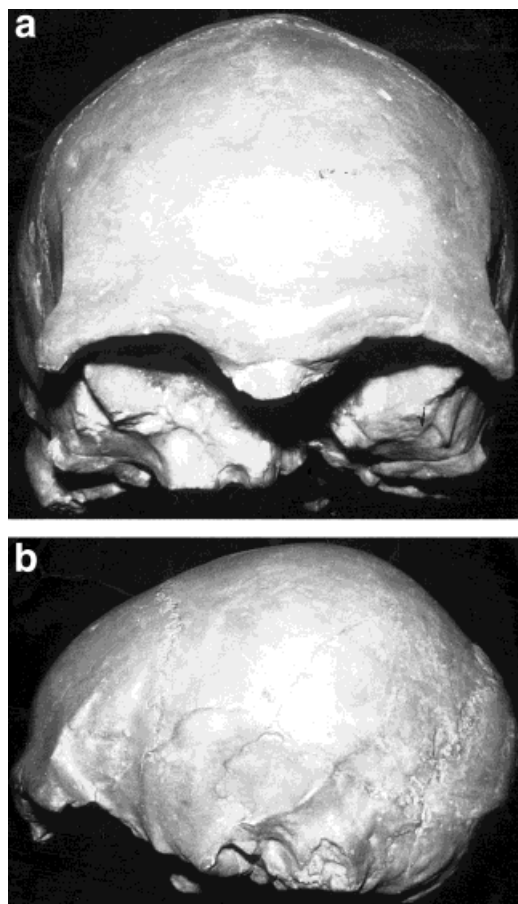


Fig. 17. Cioclovina (cast). **a:** Anterior. **b:** Lateral.

ton (Hedges et al., 1989) resulted in a date of 26.350 ± 0.55 ky BP, which is late relative to the Aurignacian on the continent (Mellars and Bricker, 1986), suggesting either an extended duration of the Aurignacian on the British Isles or an incorrect cultural diagnosis of the associated artifacts.

Cioclovina (Transalvanian Alps, Romania)

The calvarium of an anatomically modern human (Fig. 17), morphologically similar to other Central European early Upper Paleolithic modern humans, was recovered with three Aurignacian artifacts at Cioclovina (Necrasov and Cristescu, 1965). The specimen likely represents a male (Smith, 1984; contra Necrasov and Cristescu, 1965), and

is similar to other early modern crania in its expression of occipital bunning and in brow ridge morphology. Without a larger cultural component or absolute dates, the Cioclovina hominid contributes little to our understanding of the nature of the Neandertal/modern human transition, but may well be an early representative of the latter group.

Podbaba (Prague, Czech Republic)

A partial calvarium with large, projecting supraorbital tori and a low frontal squama was discovered at Podbaba in 1883. The specimen is generally thought to have derived from the Aurignacian at the site, but the exact stratigraphic provenience is unknown (Obermaier, 1905; Matiegka, 1924). Originally thought to represent a Neandertal based on its large brow ridges and low frontal (Fric, 1885), Podbaba has since been shown to be morphologically similar to other crania of early modern humans from South-Central Europe (Matiegka, 1924; Vlček, 1956; Smith, 1984). Unfortunately, the Podbaba cranium was destroyed during casting in 1921. Given its uncertain context and the impossibility of directly dating the specimen, the relevance of this specimen to biocultural dynamics of the Middle/Upper Paleolithic transition will remain uncertain.

Camargo (Santander, Spain)

During excavations in 1908 at Camargo Cave, a near neighbor of El Castillo (both sites are in the valley of the river Pas), Father Lorenzo Sierra discovered a fragmentary human calotte (Fig. 18) from a level bearing Upper Paleolithic artifacts. The lithic assemblage was attributed to the Aurignacian by Obermaier (1924),⁸ but no formal typological analysis was conducted on the Camargo artifacts before their destruction during the Spanish Civil War (Garalda, 1997). The cranial vault, also destroyed during the war, is thought to represent a female. The illustration of this specimen provided by Obermaier (1924,

⁸Prior to the reorganization by Peyrony (1933) of the early Upper Paleolithic, Gravettian assemblages were often included as part of the Aurignacian (Harrold, 2000); thus, the possibility exists that the Camargo assemblage was Gravettian in character.

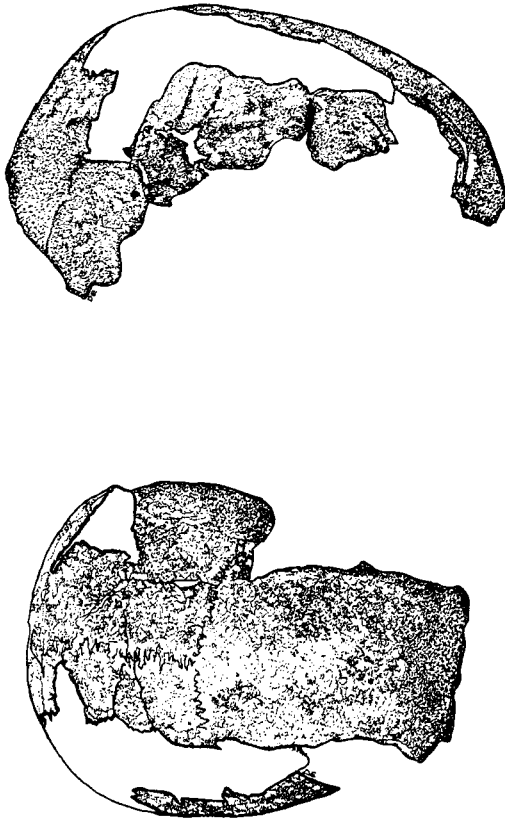


Fig. 18. Camargo cranium in lateral (top) and superior (bottom) views. Drawn from photographs in Obermaier (1924) by Dania Ermentrout.

Plate 17) shows a gracile, dolichocephalic vault with a high frontal angle and an incipient occipital bun. The region of the right supraorbital torus appears to be partially preserved and looks to be gracile and non-projecting, consistent with the female sex attribution. The specimen was considered anatomically modern by Saller (1926), and there is nothing in the published illustrations to argue against this attribution. However, given the lack of a formal typological analysis of the associated artifacts, incomplete analysis of the human material, and lack of chronostratigraphic context for the specimen, the Camargo cranial vault remains of little utility in determining the affinities of the makers of the earliest Aurignacian in Spain.

THE MAKERS OF THE EARLIEST AURIGNACIAN AND THE TIMING OF THE APPEARANCE OF MODERN HUMANS IN EUROPE

The fossil and archaeological records of the early Aurignacian are summarized in Table 6, along with our subjective assessments of the degree of confidence (low, moderate-to-good, or high) in the taxonomic and typological classifications, cultural associations, and chronological placements, based on the available evidence. Arranging the data in this manner provides a foundation for addressing the question of the timing of the appearance of modern humans and the Upper Paleolithic in Europe (Fig. 19).

The oft-cited conventional radiocarbon date of >43 ky BP for the Bachokirian in layer 11 of Bacho Kiro Cave has not been supported by further dating. More rigorous AMS dating of this layer suggests that it was deposited over a 5,000-year interval between ca. 39–34 ky BP. The appearance of the Bachokirian is roughly coincident, then, with the appearance of the early Aurignacian elsewhere, as well as with the Szeletian (*sensu lato*) and Châtelperronian (Table 1). The Bachokirian is probably best seen as part of a larger pan-European emergence of the Upper Paleolithic during Hengelo temperate conditions, rather than as an especially early forebear of the Upper Paleolithic. The single human fossil from Bacho Kiro's layer 11 is frustratingly undiagnostic with respect to taxonomy. Given the early date of the Bachokirian, the taxonomic affinities of this specimen are of extreme interest. At least one diagnostic feature, the anatomy of the dm_1 pulp cavity, suggests modern human affinities; but this single feature is not sufficient for a staunch claim that this *is* a modern human. Such certainty is unfortunately beyond our grasp at present.

The only other fossil-bearing sites that may date to the Hengelo (El Castillo and Hahnöfersand) present similar problems of interpretation. The El Castillo material falls within the ranges of variation of both Neandertals and early modern Europeans, making taxonomic diagnosis unrealizable (especially given the impossibility of further

TABLE 6. Summary of possible early Aurignacian fossil sites

	Assemblage designation ¹	Taxonomic designation of human remains ¹	Confidence in archaeological association ²	Absolute date or geologic age ¹
El Castillo/level 18	Basal Aurignacian	Uncertain	High	ca. 40–38.5
Bacho Kiro/layer 11	Bachokirian/proto-Aurignacian	<i>Modern human</i>	High	ca. 39–34 ky BP
Bacho Kiro/7/6b and 7/6a	Aurignacian	Modern human	High	ca. 33–29 ky BP
Hahnöfersand	None	Modern human	NA	ca. 36 ky BP
Vogelherd/level V	Early Aurignacian	Modern human	High	>32 ky BP
Riparo Bombrini	Early Aurignacian	Modern human	High	34.5–31.5
La Ferrassie/Level E'	Aurignacian 0	<i>Modern human</i>	High	<i>34–32</i>
Vindija/Level G ₁	<i>IUP with Aurignacian elements</i>	Neandertal	Moderate-low	ca. 33–28 ky BP
Vindija/Level F	<i>Aurignacian</i>	Uncertain	High	ca. 27 ky BP
Mladeč	Early/middle Aurignacian	Modern human	Moderate-high	Würm IIIa
Zlatý kůň	<i>Aurignacian</i>	Modern human	Moderate-high	Würm IIIa or IIIb
Fossellone	Early Aurignacian	Modern human	High	33–31.5
Kelsterbach	None	Modern human	NA	ca. 32–31 ky BP
Kent's Cavern	<i>"Aurignacoid" British early Upper Paleolithic</i>	Modern human	Moderate-low	ca. 31 ky BP
Cioclovina	<i>Aurignacian</i>	Modern human	Moderate	None
Podbaba	<i>Aurignacian</i>	Modern human	Poor	None
Camargo	<i>Aurignacian</i>	Modern human	Moderate	None

¹ Our assessment of the degree of confidence associated with the assemblage designation, taxonomic designation, and absolute date of each site is indicated as follows: **bold text**, high confidence; plain text, moderate-to-good confidence; *italicized text*, low confidence. All dates in ky BP.

² Confidence in association of human remains with early Aurignacian component of site.

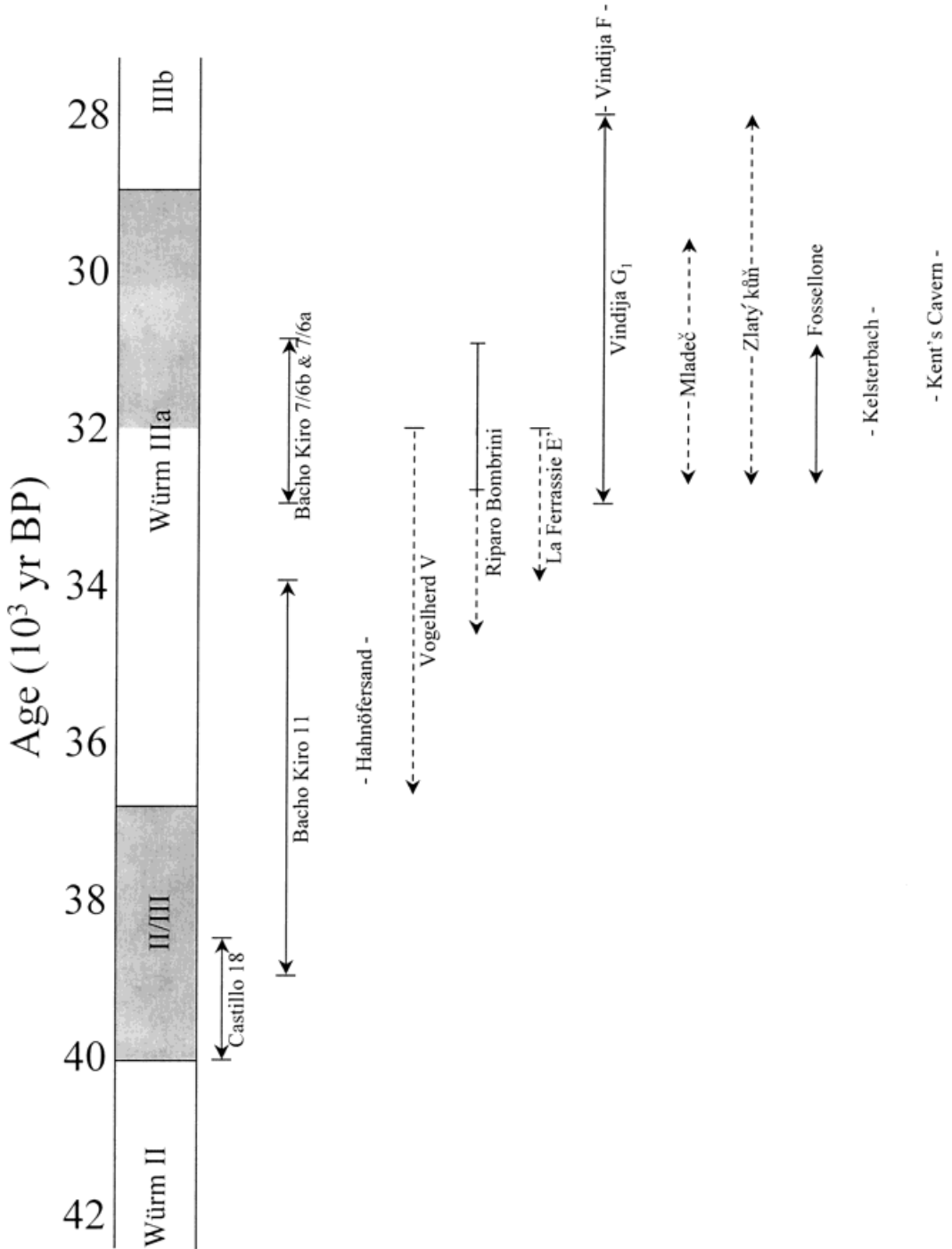


Fig. 19. Temporal distribution of archeological levels with human remains and Aurignacian assemblages or Aurignacian-like tools. Ages are in (uncalibrated) radiocarbon years; the Hengelo and Denekamp interstadials are indicated by shading on the Würm chronology. Dashed lines indicate a greater than usual uncertainty in dating. The undated sites of Cioclovina, Podbaba, and Camargo (see text) are not included.

analysis of the specimens). The Hahnöfersand frontal has a basically modern morphology but lacks an archaeological context. Given the lack of context and the recent demonstration that the morphologically similar specimen from Velika Pećina does not date to >34 ky BP (Smith et al., 1999), unequivocal acceptance of the 36 ky BP age for Hahnöfersand will require redating of the specimen with the more precise techniques now available (e.g., AMS radiocarbon dating).

The unquestionably modern human fossils from the lower portion of Vogelherd level V may rate as the earliest well-provenienced and confidently classified modern human fossils in Europe. At present, we know that the Vogelherd 1 and 3 specimens are likely older than 32 ky BP, but if we are correct that paleoenvironmental indicators designate probable contemporaneity of Vogelherd layer V and Geißenklösterle level III, the Vogelherd skeletal material may date to the end of the Hengelo interstadial or to early Würm IIIa times. Also in this end-Hengelo time range may go the isolated teeth from Riparo Bombrini and La Ferrassie Level E'. The teeth are of questionable modernity (in both cases they appear to be more similar to early moderns than to Neandertals, but secure attributions cannot be made on the basis of single teeth) and questionable age, but their associations with early Aurignacian assemblages, along with the associated paleoclimatic indicators, suggest an early Würm IIIa date.

In sediments dating to the end of the Würm IIIa stadial and beginning of the Denekamp interstadial, diagnostically modern human fossils become more frequent, with many of them (e.g., Mladeč, Zlatý kůň, Kent's Cavern) in association with Aurignacian type-fossils. To this group can likely be added the undated specimens from Fossilone. Finally, the culturally unaffiliated modern human cranium from Kelsterbach may derive from this period if its provisional date of 32–31 ky BP can be substantiated.

Based on the current state of the fossil and archeological records, we can draw some tentative conclusions. First, we can confidently say that modern humans were established in Europe by mid-late Würm

IIIa times (by ca. 32 ky BP). There is a strong suggestion that modern humans had settled in Europe by end-Hengelo times (ca. 36 ky BP), but this must remain only a suggestion until further dating of the specimens from Hahnöfersand and Vogelherd is accomplished. Claims for an appearance of modern humans in Europe before 36 ky BP, including claims based on dated archeological complexes lacking fossil human remains, cannot be substantiated with currently available fossil evidence.

Second, the hypothesis that modern humans are uniquely associated with the Aurignacian cannot yet be refuted. As Table 6 demonstrates, all *reasonably diagnostic* human remains *confidently* associated with the Aurignacian represent modern humans. The single current best argument against this hypothesis is the case of the Vindija G₁ Neandertals, but even if the G₁ artifact assemblage is not artificially mixed, its typological attributes are uncertain (Karavančić and Smith, 1998). Thus, Vindija may stand in parallel with St. Césaire and Arcy-sur-Cure as a testament to the Upper Paleolithic cultural abilities of Neandertals, but not necessarily to their production of the Aurignacian *sensu stricto*. However, it is important to bear in mind that none of the confidently Aurignacian associated modern human skeletal remains have been shown to predate ca. 32–33 ky BP (although those from Vogelherd V may). Given the uncertainty surrounding the origin of the Aurignacian, we should not be confident that the earliest Aurignacian *must have been made* by modern humans until we have the appropriate fossil associations.

Third, whatever the ecological and cultural dynamics promoting the emergence of the Upper Paleolithic in Europe, Neandertals were a part of those dynamics. On the western (Iberian) and eastern (Russian) fringes of their range, the last Neandertals seem to have held to a Mousterian way of life to the bitter end. But between these extremes Neandertals appear to have been full participants in the evolving Upper Paleolithic. Cultural materials from Neandertal-bearing levels at St. Césaire, Arcy-sur-Cure, and Vindija, which include bone tools and items of personal adornment, suggest

that Neandertals had cultural capacities on a par with those of early modern humans. Similarities in the behavioral repertoires of Châtelperronian Neandertals and Aurignacian and Gravettian modern humans are further suggested by biomechanical analyses of the St. Césaire long-bone diaphyses (Trinkaus et al., 1998, 1999). Further evidence that Neandertal behavioral capacities were comparable to those of modern humans derives from recent suggestions that Neandertals were effective and efficient hunters, apparently taking all of their dietary protein from meat (Bocherens et al., 1999; Richards et al., 2000). While the most appropriate typological designation of the Vindija G₁ assemblage remains uncertain, the very difficulty we face in making this designation underscores the similarity in the cultural behavior of the Vindija G₁ Neandertals and Aurignacian modern humans.

Fourth, by conservative estimates, Neandertals and modern humans coexisted in Europe for 2,000–4,000 years. If modern humans did arrive in Europe during Hengelo times, this coexistence may have been more on the order of 8,000–10,000 years. The geographic location of fossil sites provides an idea of the minimum proximity of these groups of humans. Thus during late Würm IIIa times, for example, we can say that the Neandertals of the Hrvatsko Zagorje of Croatia (at Vindija) likely had modern human neighbors in Moravia (Mladeč) and Bohemia (Zlatý kůň), about 400 km to the north, and within 600 km to the northwest (in southern Germany, at Vogelherd), and possibly west (in Liguria, if the Riparo Bombrini incisor represents a modern human). The isolated incisor from La Ferrassie is roughly contemporaneous with the Châtelperronian Neandertal remains from St. Césaire and Arcy-sur-Cure. If this specimen represents a modern human (unfortunately this is a call that cannot be made with any confidence on present evidence), it would signal very close proximity between these groups. It is tempting to use the close geographic association of IUP and Aurignacian sites (and the possible interstratification of these assemblages within some sites) to argue for close proximity be-

tween Neandertal and modern human populations in Interpleniglacial times. To do so, however, requires the assumption that specific lithic cultures equate with specific types of hominids, the circularity of which (in the context of this review) has not escaped us. Given that the evidence reviewed above does not allow for the rejection of a Neandertal-IUP and modern human-Aurignacian association, all we can say at present is that these groups had a considerable period of co-occupation of Europe, and that the associated archeological record *suggests* close contact between them.

It is difficult to imagine a co-occupation of Europe of 2,000–4,000 years or longer without a substantial amount of cultural exchange between human groups, and without a substantial degree of adaptive parity (which is not to say adaptive equality—differences in adaptive strategies may well have existed between groups; Churchill et al., 1996). Despite paleogenetic evidence to the contrary (Krings et al., 1997, 1999; Ovchinnikov et al., 2000; but see Nordburg, 1998), consideration of certain morphological details evident in the last Neandertals and the earliest modern humans in Europe suggests that this coexistence also entailed a significant degree of genetic exchange as well (Trinkaus and Smith, 1985; Smith et al., 1989a; Smith and Trinkaus, 1991; Duarte et al., 1999). It is important to note that the evidence for morphological, and presumably genetic, continuity between European Neandertals and early modern humans is found in anatomical details and not fundamental aspects of morphological form. Late Neandertals from Vindija (G₁ and G₃), Kůlna, Barakaevskaia, Grotte du Renne, St. Césaire, and Zafarraya are unequivocally identifiable as Neandertals, yet many of these specimens have morphological details that approach the modern human condition (Smith 1984, 1994; Smith and Trinkaus, 1991; Wolpoff, 1999). Although there is always the possibility that these details reflect parallelisms, the most logical explanation in our opinion is low-level gene flow from modern populations that were beginning to colonize Europe during Hengelo times (or from populations on the peripheries of Europe prior to the period of active

colonization). The overall morphological form of early modern Europeans such as those from Mladeč, Vogelherd, Zlatý kůň, or Hahnöfersand is clearly distinctive from that of Neandertals. Furthermore, the basic similarity of early modern European morphology to that of the Skhul/Qafzeh sample from the Near East is evident (Vandermeersch, 1981; Tillier, 1999; Holliday, 2000). Given that fossils from Skhul/Qafzeh antedate any early modern European, it seems logical to view the former as having had a significant role in the origin of modern humans in Europe. However, there are strong indications that Neandertals were not shut out of this process. Early modern Europeans have a series of anatomical details (e.g., similar frequencies and patterns of mandibular foramen form, retromolar spaces, suprainiac fossae, and occipital bunning) that appear to derive from Neandertal contribution to their gene pools (Smith, 1984; Frayer, 1992; Frayer et al., 1993; Wolpoff, 1999).

The phylogenetic significance of Neandertal-reminiscent features in early modern Europeans remains unclear (e.g., Caspari, 1991; Lieberman et al., 2000 on occipital bunning). Some of these features may be shared primitive traits, or the product of parallel evolution, and thus of little use in assessing the phylogenetic relationships between these groups. However, we see in the morphology of these groups a situation analogous to that of the emergence of IUP cultures in Europe. In a query that applies equally to all the various IUP industries that proliferated in the early Interpleniglacial, Harrold (2000, p. 70) asks, "If the Châtelperronian developed autochthonously, why did it do so after a long period of Mousterian adaptive stability and just before the local appearance of the Aurignacian?" Likewise we can ask of the fossil evidence: 1) Why, after at least 200,000 years of morphological divergence from the presumed modern human lineage in Africa, did Neandertals begin to converge on details of morphology with modern humans, at precisely the time that modern humans seem to have been expanding their range into Europe? This "convergence" is evident in specimens from western France (Vandermeersch,

1984) to the northern Caucasus (Lioubine, 1998). 2) Why, in the absence of genetic exchange, would early modern humans, only upon entering Europe, independently develop Neandertal-reminiscent features—features that are largely absent in their presumed ancestors from the Near East?

In our opinion, the best explanation for this situation is the "assimilation" of Neandertals into the modern populations that likely entered Europe from the east and south, introducing some Neandertal elements into the early modern European gene pool. The opportunity for such biological interaction is certainly enhanced by the growing evidence for a substantial period of overlap between these populations in Europe. Assimilation rather than *in situ* evolution is supported by the fact that, even at the end of this overlap, Neandertal and early modern populations remained fundamentally distinct from each other, only evincing indications of biological integration in a relatively few specific morphological features.

Virtually all current perspectives on modern human origins are willing to accept the possibility of genetic exchange between Neandertals and early modern Europeans. Leading proponents of a "Recent African Origin" for all modern humans do not rule out, at least theoretically, some Neandertal contribution to early modern gene pools; but it is clear from their writings that such contributions were at best minimal, and perhaps bordered on the insignificant (Bräuer, 1992; Stringer and Bräuer, 1994; Bräuer and Broeg, 1998). The "Multiregional Evolution Model," on the other hand, is fundamentally based on the existence of significant, but variable, patterns of genetic exchange between regional lineages of humans throughout the Middle and Late Pleistocene (Frayer et al., 1993; Wolpoff, 1999). In a recent discussion of the emergence of modern morphology in Europe, Frayer et al. (nd) concluded that the majority contribution to this morphology did not derive from Neandertals and thus entered Europe via gene flow. However, they did not view this gene flow as the catalyst for the emergence of early modern European morphology, nor did they accept the idea that modern morphology has a

specific region of origin (Frayser et al., 1993, p. 42). In contrast, our view of this process considers gene flow from outside Europe to have been the catalyst for the appearance of modern Europeans. We interpret the "transitional" morphology of some late European Neandertals as likely related to low levels of gene flow by demic diffusion into Europe just prior to ca. 35 ky BP. However, the emergence of definitively modern humans (around or just after this date) is most logically due to a systematic increase in gene flow (cf. Trinkaus and Smith, 1985) in the form of population movements into Europe at this time. At the same time, our interpretation of the morphology of early modern Europeans convinces us that Neandertals *must* have been far from insignificant in the morphological and genetic makeup of this population. In other words, we see evidence of a significant "assimilation" of Neandertals into a fundamentally modern, immigrant population.

The origin of modern human morphology, based on the current state of the fossil and geochronological records, appears to have been centered in Africa in the late Middle Pleistocene (Beaumont et al., 1978; Singer and Wymer, 1982; Rightmire and Deacon, 1991). There are also indications from the archeological record that some aspects of modern human behavior (or perhaps more precisely, Upper Paleolithic behavior: notably symbolic expression, bone working, and the production of sophisticated composite extractive technology) also arose in sub-Saharan Africa during Middle-to-Late Pleistocene times (Wendt, 1976; Brooks et al., 1995; Yellen et al., 1995; Deacon and Wurz, 1996; Henshilwood and Sealy, 1997). While there is a natural tendency to view the emergence of modern form and modern behavior as causally related (see Churchill, 1997), hominid-cultural associations outside of Africa (McCown and Keith, 1939; Lévêque and Vandermeersch, 1980; Hublin et al., 1996) urge caution in uncritically accepting this notion. Much of the classic research in European prehistory was done within a paradigm that saw modern humans as having had a greater capacity for cultural behavior, and that envisioned a clear distinction between the Middle Paleo-

lithic of the Neandertals and the Upper Paleolithic of modern people (amply reflected in the quote by Le Gros Clark at the beginning of this review), and much recent effort has been devoted to untangling the hard evidence from the preconceptions that surround it.

In this vein we are careful to point out that although movement of populations from the south probably had a catalytic effect on the biological emergence of modern Europeans, there is certainly no evidence that this occurred in concert with the origin of the Aurignacian. The oft-repeated implication that the appearance and spread of both in Europe must have occurred together is not demonstrated by the available evidence. In fact, the origin of the Aurignacian remains somewhat of a mystery and may well be an internal event (perhaps even a series of independent events) in Europe.

The emergence and florescence of the Upper Paleolithic across Europe were no doubt a response to the climatic volatility and cultural dynamics of the Interpleniglacial. Certainly an important part of that cultural dynamic was the interaction between morphologically different, and possibly behaviorally different, groups of people who shared the region. Scholarly understanding of the nature of that interaction has improved substantially in recent years. Although we certainly do not yet have all the answers to the questions posed at the beginning of this review, there are some very clear patterns emerging (as presented in the preceding paragraphs). Furthermore, it is important to bear in mind that we are beginning to delve into very detailed aspects of population and cultural dynamics in Late Pleistocene Europe. This level of analytical detail cannot be applied to earlier periods in the human evolutionary record, nor even to other geographic regions in the Late Pleistocene. Thus, it is not surprising that many of these questions continue to be the focus of healthy scientific debate. Despite this, it is becoming increasingly apparent that simple conceptions of cultural superiority and supplantation (the "colonial metaphor:" Graves, 1991) are inadequate for understanding the events of the Middle-to-Upper Paleolithic

transition and the demise of the Neanderthals on the European continent.

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