

New dates for the Fontéchevade (Charente, France) *Homo* remains

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Abstract

Homo I from the site of Fontéchevade, France, has long been an anomaly in the European fossil record. The specimen is a fragment of human frontal bone that lacks a supraorbital torus and appears to belong to an anatomically modern *Homo sapiens*. However, the level from which it was recovered in 1947 was dated on the basis of associated faunal and lithic material to the last interglacial or earlier. As a result, *Homo I* has been interpreted, among other things, as a representative of a pre-sapiens lineage in Europe. This paper reports on recent ESR and radiocarbon dates that indicate that the specimen almost certainly dates to oxygen isotope stage 3, which brings it in line with other evidence for the entry of modern *Homo sapiens* into Europe.

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Introduction

A fragment of human frontal bone (*Homo I*) was discovered in the cave of Fontéchevade (Charente, France) in 1947 by Germaine Henri-Martin, below Middle and Upper Paleolithic levels. It was dated to the last interglacial (OIS 5a) or earlier based on its association with (1) a warm-climate fauna, (2) a crude “Tayacian” stone-tool industry, and (3) a morphologically more archaic specimen (*Homo II*)

(Bouchud, 1957; Henri-Martin, 1957). Its “modern” appearance, which does not fit with this inferred early age, posed a problem for paleoanthropologists. Initially, this fossil and the recognizably more archaic *Homo II* specimen were used to support a “pre-sapiens” lineage in Europe during the early Upper Pleistocene¹ (Heberer, 1951, 1955; Vallois 1958), a view that conflicts with what is now known of the European fossil record. Here we report new radiometric dates on vertebrate faunal remains associated with the *Homo* fossils. These dates, placed in the context of the results of our own recent re-excavation of the site, suggest a much later (OIS 3) date for the hominin remains.

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¹ Equivalent to the late Pleistocene of North American usage; “Upper Pleistocene” is used herein, following conventional European usage.

Fontéchevade was excavated by Germaine Henri-Martin (1957) from 1937 to 1954. Relatively thin levels of Bronze Age, Aurignacian, Châtelperronian, and Mousterian overlay a brecciated roof-fall, below which was a thick (6 m) bed, designated E, which she excavated in arbitrary levels. Because of associated warm-climate fauna, as well as the crude appearance of the Tayacian industry, bed E has generally been considered to date to the last interglacial (Bouchud, 1957) or even earlier (Rigaud and Vandermeersch, 1976).

Homo I came from the uppermost arbitrary level, E0 (in Henri-Martin's stratigraphy), from the base of a layer of brecciated roof-fall (Fig. 1). A calotte (partial skull cap), *Homo II*, was found about 2 m farther into the cave and slightly below *Homo I*, in the level designated E1'.

Homo I consists of a partial frontal bone that includes the glabellar region, the medial portion of the left superciliary arch, and a small part of the squama above these. What is remarkable about this piece, given its apparent antiquity, is the complete absence of a supraorbital torus. This, as well as the thinness of the squamous portion, gives the frontal a very modern appearance. *Homo II* consists of the upper part of a frontal bone and portions of left and right parietals. The specimen, much more archaic in appearance, is distinguished by the thickness of its cranial walls.

Vallois (1949, 1958), who was the first to study the Fontéchevade material, assumed that the two specimens, *Homo I* and *Homo II*, represented the same biological population. He argued that both lacked a supraorbital torus, and that they represented a "pre-sapiens" lineage that included the Swanscombe population (represented by the Swanscombe calotte) and anatomically modern Upper Paleolithic and present-day humans.

Most of those who have analyzed the Fontéchevade remains, with the exception of Heberer, have disagreed with this interpretation. Brace (1964), Drennan (1956), and Trinkaus (1973) argued that *Homo I* might be interpreted as a juvenile Neandertal, with the adult supraorbital torus not yet developed. Sergi (1953a, b, 1967), Weiner and Campbell (1964), and

Howell (1951, 1957, 1958) all argued that *Homo I* was too small a fragment to serve as the basis for such a consequential taxonomic interpretation. Howell also explicitly questioned the association of *Homo I* and *Homo II* on theoretical grounds, but he noted differences in mineralization and questioned a fluorine test (Oakley and Hoskins, 1951) that indicated contemporaneity of *Homo I* and the Tayacian fauna.

Henri-Martin excavated the front half of the cave to several meters below where *Homo I* was found. Our excavations began at the profile she left, 9 m farther into the cave from where *Homo I* was found. We uncovered a very complex stratigraphy, although she had distinguished no natural layering within bed E and, as noted above, had excavated in arbitrary levels (Fig. 1).

Because no heated flints or faunal remains were recovered in the area in which we excavated, we were unable to date the sediments corresponding to those in which the *Homo* remains were found. Thus, we could date the hominin remains only by using material from Henri-Martin's excavations.

We selected for AMS radiocarbon dating five fragments of unidentifiable mammalian bone from a box marked as containing material from "near" *Homo II* ("Ossements trouvés près du crâne *Homo II*"). Amino-acid analysis of the specimens showed that they were highly suitable for dating, although mineral staining indicated that they came from two different series.

The bone fragments used for radiocarbon dating ranged from white to yellowish brown and were coated with varying amounts of iron and manganese oxides. The preliminary hypothesis was that permineralization was related to geologic age and stratigraphic position. Data collected during chemical purification of the bone augmented physical descriptions. Six cortical-bone samples were tested chemically; three were dated by AMS ^{14}C using XAD-purified collagen (Stafford, et al. 1991) to $33,720 \pm 410$ (UCIAMS-11216), $33,360 \pm 380$ (UCIAMS-11217), and $>51,700$ (UCIAMS-11218) years ($\delta^{13}\text{C}$ -corrected, uncalibrated ages) (Table 1). Cortical-bone fragments and decalcified collagen were either significantly discolored with iron- and manganese-oxide

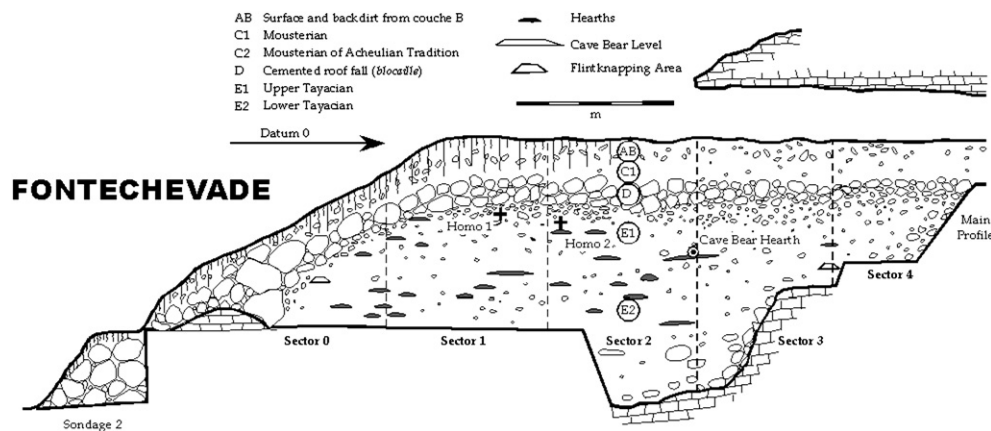


Fig. 1. Sagittal profile of Fontéchevade, as drawn by Henri-Martin (1957; redrawn from her Figure 9). She did not recognize natural stratigraphy within the entire depth of bed E.

Table 1
Radiocarbon-dating samples

SR	Type of bone	Date	Decalcified collagen pseudomorphs		Wt% protein	Color
			in HCl	in KOH		
SR-6717	Cortical bone	33,720 ± 410	99	98	5.30%	Pale yellowish brown
SR-6718	Cortical bone	33,360 ± 380	97	96	6.20%	Dark yellowish brown
SR-6719	Cortical bone	—	5	0		Ext. pale yellow
SR-6720	Cortical bone	—	98	98		White (opaque)
SR-6721	Cortical bone	>51,700	97	97	7.40%	Ext. pale yellow
SR-6722	Rib	—	85	85		White (opaque)

mineralization or the bones and collagen had minimal mineralization. Brown to yellow-brown collagen samples dated to 33 ka; the unstained specimen dated to >51 ka. Protein yield compared to 20–22% in modern bone varied from 5.3% to 6.2% for 33-kyr-old specimens to 7.4% for the >51-kyr-old specimen. All dated specimens yielded 96–98% pseudomorphs of collagen, while two bones had 85% and 0% pseudomorphs (Table 1). These data are similar to those from Grotte XVI, France (Stafford, et al. 1991), where collagen preservation initially decreased with increasing geologic age, then improved in the oldest bones because older bones experienced less environmental variation than more shallowly interred fossils. The Fontéchevade data are an indication that (1) two age-populations (ca. 33 ka and >51 ka) of bones are present, (2) collagen preservation and mineralization are age-related, and (3) greater mineralization in younger bones may be related to downward moving waters.

In addition, we selected five bovine (*Bos* and/or *Bison*) teeth from upper bed E for electron spin resonance (ESR) dating. Their depth varied from 2.60 to 2.85 m below Henri-Martin's datum. *Homo* I was found at a depth of 2.40 to 2.60 m; *Homo* II, at 2.60 to 2.80 m. (Henri-Martin did not record horizontal provenience.) The age of a fossil tooth can be determined from a characteristic ESR signal, the intensity of which is proportional to the radiation received from surrounding sediment and the amount of uranium incorporated into the tooth (Rink, 1997). Part of the enamel of the five teeth plus one replicate pair (99FCH5A,B) was powdered and aliquots were irradiated with γ -rays from a ^{60}Co source, with doses ranging up to 500 Gy (Table 2). The $g = 2.0018$ signal was measured on a JEOL JES-FA100 ESR spectrometer. The dose-response curves were constructed using the ESR-signal intensities, fitted with a single saturating exponential function using VFIT software of E. Bulur. Uranium (U), thorium (Th), and potassium (K) concentrations in sediment and U concentrations in dental tissues were obtained by neutron activation at the McMaster Nuclear Reactor. Cosmic-ray dose was estimated on the basis of depth (vertical provenience) following Prescott and Hutton (1988). We assumed average values of water content of the sediment and teeth for cave sites in this region.

Due to the low U content of the teeth, calculated ages of the teeth depend largely on the composition of the surrounding sediment and the resultant β - and γ -dose rates. Sediment attached to two of the bovid-tooth samples and a sample of sediment from Layer E from Henri-Martin's excavations yield

similar values for U, Th, and K (Table 3). Ages calculated assuming early and linear uptake (EU, LU) overlap at 1σ (Table 4). The ages for all teeth (plus the subsamples) are remarkably uniform and suggest that the sediment in which they were buried was quite homogeneous and not very stony ("lumpy"; Brennan et al., 1997). The best estimate of the age of deposition of the teeth at this site is taken to be the average of the ages obtained using the two dose-rate estimates: 39 ± 2 ka.

The fauna from Layer E includes *Equus* aff. *germanicus* (horse), *Equus hydruntinus* (ass), *Dicerorhinus merckii* (Merck's rhinoceros), *Sus scrofa* (pig), Bovinae (*Bos* and *Bison*), *Cervus elaphus* (red deer), *Capreolus capreolus* (roe deer), *Dama dama* (fallow deer), *Crocota crocota spelaea* (cave hyena), *Canis lupus* (wolf), *Cuon alpinus* (dhole), *Panthera spelaea* (cave lion), *Ursus spelaeus* (cave bear), and *Vulpes vulpes* (fox). This temperate fauna is typical of the early Upper Pleistocene (early stage 5). However, the collection of bones found near the *Homo* II skull included the radius of a reindeer (*Rangifer tarandus*), which is not compatible with an interglacial date. One possible explanation is that this bone was intrusive from the overlying Mousterian or Châtelperronian layers, which contained a cold-climate fauna.

However, Paletta (2005) confirmed that the upper parts of E (E0 and E1) contained species typical of cold, open environments: *Rangifer tarandus* (reindeer), *Marmota marmota* (marmot), *Cricetus cricetus* (hamster), *Lagurus lagurus* (lemming), *Prunella collaris* (alpine accentor), and *Plectrophenax nivalis* (snow bunting). Paletta considered these faunal elements to be intrusive, but they are compatible with the radiometric dates reported here. This faunal difference may indicate that the bulk of bed E is older than the upper part, which is quite possible given Henri-Martin's failure to recognize geological stratigraphy within E.

Table 2
Summary of data for ESR dating (teeth)

Sample	U (ppm)		Enamel stripped (μm)		Equivalent dose (Gy)
	enamel	dentine	outside	inside	
99FCH1A	0.15	9.93	99	51	46.7 ± 1.7
99FCH2A	0.09	18.10	71	54	62.7 ± 0.9
99FCH3A	0.08	16.10	74	62	50.0 ± 1.5
99FCH4A	0.01	0.13	126	118	53.8 ± 2.0
99FCH5A	0.00	0.20	72	48	37.5 ± 0.7
99FCH5B	0.00	0.12	77	108	41.8 ± 0.8

Table 3
Summary of data for ESR dating (sediments)

	U(ppm)	Th(ppm)	K %
Sediment attached to teeth			
Sample a	3.16	8.3 ± 0.6	0.62 ± 0.02
Sample b	4.62	11.7 ± 0.8	0.91 ± 0.02
Sediment from Henri-Martin's excavations			
	5.08	10.0 ± 1.7	1.02 ± 0.15

Sediments from Henri-Martin's excavations were obtained from the Musée d'Archéologie Nationale, Saint-Germain-des-Près.

Discussion and conclusions

In sum, materials of three different ages underlie the brecciated roof-fall that isolated the Tayacian from later Mousterian and Upper Paleolithic deposits.

1. Material dated by AMS ^{14}C to approximately 33 ka was in close association with *Homo II*.
2. Material from the same depth as *Homo II* and deeper than *Homo I* was dated by ESR to about 39 ka. The discrepancy between the two sets of dates may be attributable to a dramatic increase in atmospheric ^{14}C at about 40–41 ka (Giaccio et al., in press).
3. Finally, one ^{14}C date of >51 ka may indicate some stratigraphic mixing.

It is possible that either *Homo I* or *Homo II*, or both, may have been redeposited. However, there are three reasons to believe that the great majority of the material from Henri-Martin's excavation was in situ rather than intrusive, and that it dated to OIS 3.

1. The presence of cold-climate faunas in the upper part of Layer E is consonant with an OIS 3 age. The recovery of a reindeer bone near *Homo II* indicates the same thing. (It would indicate mixing only if the top of bed E dated to early OIS 5.)

Table 4
ESR ages

Sample	Sediment from museum		Sediment attached to teeth (average)	
	EU	LU	EU	LU
99FCH1A	34.6 ± 2.9	37.1 ± 3.3	38.0 ± 3.5	41.2 ± 4.2
99FCH2A	40.3 ± 3.1	43.8 ± 3.7	44.5 ± 3.9	48.9 ± 4.7
99FCH3A	35.8 ± 2.9	38.0 ± 3.3	39.7 ± 3.7	42.4 ± 4.2
99FCH4A	39.4 ± 4.0	39.5 ± 4.0	44.6 ± 5.1	44.6 ± 5.1
99FCH5A	30.8 ± 2.7	30.8 ± 2.7	34.5 ± 3.6	34.6 ± 3.6
99FCH5B	33.9 ± 3.1	33.9 ± 3.1	38.0 ± 4.0	38.1 ± 4.0
Average	35.8 ± 3.2	37.1 ± 4.1	39.8 ± 3.6	41.6 ± 4.5

External γ - and β -dose rates were calculated from the U, Th, and K concentrations of sediment samples shown in Table 3. Ages were computed using ROSY version 2.0 software. Cosmic-ray dose rate assumed a burial depth of 10 m and a water content of 20% and 5% in sediment and dentine, respectively.

2. Our excavations revealed reworked beds along the cave walls that Henri-Martin did not recognize. However, these contained obviously out-of-place archaeological material, most notably Upper Paleolithic lithics and allochthonous raw materials. No such material was found in her collections from bed E, indicating that what she excavated was for the most part in situ.
3. Most significantly, with a single exception, the radiometric dates indicate an OIS 3 age for the upper part of E. The AMS ^{14}C dates come from specimens associated horizontally with *Homo II*. The ESR dates come from elsewhere in upper bed E.

If, as all of these facts indicate, the bulk of the material from the upper part of bed E was in situ and dated to OIS 3 rather than to early OIS 5 or before, then it would be going against the odds to assign a date other than OIS 3 to either *Homo* specimen.

Moreover, an OIS 3 date simplifies the taxonomic and evolutionary interpretations of these two specimens. There is now abundant evidence that both Neandertals and anatomically modern *Homo sapiens* lived in Europe during OIS 3 (Koslow-ski, 1982; Smith 1984; Stringer 1990; Mercier et al. 1991, 1993; Hublin et al., 1995, 1996; Karavanic and Smith, 1998; Pettitt 1998; Smith, et al. 1999; Antunes et al., 2000; Walker, 2001; Schmitz, et al. 2002; Beauval et al., 2005; Gravina et al., 2005; Morin et al., 2005; Higham et al., 2006). If *Homo I* dates to OIS 3, then there is no reason to find grounds for interpreting its morphology as that of a Neandertal in spite of its prima facie modern appearance. Brace (1964), Drennan (1956), and Trinkaus (1973) all attempted to do so because if it dated to OIS 5a or earlier, then the only alternative was to invoke the presence of a “pre-sapiens” lineage in Europe. Likewise, there is no reason to interpret *Homo II* as part of an anatomically modern or “pre-sapiens” population, as Vallois and Heberer did. If, in accordance with the majority view, it is a Neandertal, it would date to the late Middle Paleolithic.

The more modern looking *Homo I*, if it was in situ, must be somewhat later and likely overlaps in time with the directly dated modern remains from Pesteră cu Oase, Romania (Trinkaus et al., 2003). In either case, there are no chronological grounds for interpreting *Homo I* as a Middle Pleistocene “pre-sapiens,” and it is clear that the upper part of bed E at Fontéchevade dates to OIS 3.

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