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Current issues in late Middle Palaeolithic chronology: New assessments from Northern Iberia

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ABSTRACT

The Iberian Peninsula plays a central role in the current debates on the Middle-Upper Palaeolithic transition and the Neanderthal extinction. This is largely due to the chronological data which some authors have suggested show a clear divide between Northern Iberia, where the Upper Palaeolithic appeared as early as 36.5 ka ^{14}C BP, and Southern Iberia, where the Middle Palaeolithic survived until ca. 32–30 ka ^{14}C BP or later. The best example of this view is the Ebro Frontier hypothesis. However, there are chronological data in both Northern and Southern Iberia that do not fit this pattern, and some of the evidence supporting the Ebro Frontier hypothesis has been questioned in recent years. This paper focuses on the chronology of the final Middle Palaeolithic of Northern Iberia, where several assemblages have been found to post-date the first Upper Palaeolithic in the region, and be of a similar age to the final Neanderthal occupations of the south. In order to improve the chronological framework of the Middle-Upper Palaeolithic boundary in the Northern Iberian Peninsula, a radiocarbon dating program is focused on sites from both the Cantabrian and Mediterranean regions. The first results of this program are presented in this paper. New radiocarbon dates have been measured by two laboratories using a range of pre-treatment methodologies. These do not support a late Middle Palaeolithic in Northern Iberia.

1. Introduction

The substitution of Neanderthals by Anatomically Modern Humans (AMH) has been a central issue in archaeological and palaeoanthropological research in recent years. The Iberian Peninsula plays a special role in this debate, as chronological and archaeological evidence provides the strongest claim for the coexistence of the two populations on a peninsular scale. On the one hand, the dating of Aurignacian levels at certain northern sites, such as Arbreda, Abric Romaní, and La Viña (Bischoff et al., 1989, 1994; Fortea, 1996), has indicated that Upper Palaeolithic industries, presumably manufactured by AMHs, arrived around 38–36 ka ^{14}C BP (44–42 ka cal BP). On the other hand, Neanderthals and Middle Palaeolithic industries appear to have persisted in Southern and Central Iberia until at least 30 ka ^{14}C BP, as indicated by the recent dates obtained from Gorham's Cave, Oliveira, Jarama VI and Cabezo Gordo (Finlayson et al., 2006; Zilhão, 2006; Jordá Pardo, 2007; Walker et al., 2008). This suggests nearly 10 ka of coexistence. On the basis of these data, some authors have proposed a clear-cut pattern of biological and cultural distribution for this period. The most widely-known of these hypotheses, the "Ebro Frontier" hypothesis, is based on a biogeographical barrier located south of the Pyrenees and Cantabrian Cordillera in Northern Iberia at

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approximately 42°N (Zilhão and d'Errico, 1999; Zilhão and Trinkaus, 2002; Zilhão, 2006). This chronological pattern underlies the theory of the hybridization process used to explain the anatomical characteristics of some human fossils (Zilhão and Trinkaus, 2002).

Nevertheless, some data indicate that this pattern is not so clear. On the one hand, some northern sites with Mousterian industries – El Esquilleu, Ermitons, La Güelga, Cova Gran (Maroto et al., 1996; Baena et al., 2005; Menéndez et al., 2005; Martínez-Moreno et al., 2010) have yielded recent dates, suggesting that the end of the Middle Palaeolithic could be later in the north of the Iberian Peninsula than previously thought. On the other hand, some early Upper Palaeolithic assemblages have been found in the south of the Iberian Peninsula that seem to be older than the previously published dates from the latest Neanderthal assemblages at sites such as Zafarraya (Málaga) (Hublin et al., 1995). At Bajondillo Cave (Málaga) and Foradada Cave (Alicante), some early Upper Palaeolithic occupations have been dated at 32–33 ka ^{14}C BP (Casabó, 2001; Cortés et al., 2005). In addition, other sites previously used to support this coexistence can currently be dismissed due to a variety of problems concerning dating (Zafarraya), cultural attribution (El Castillo), or a lack of reliable radiocarbon dates (Cova Negra, Carihuela) (Villaverde and Fumanal, 1990; Vega, 1993; Cabrera et al., 2001; Barroso, 2003). In particular, dating of Zafarraya seems to be more complicated, and it is possible that the Middle Palaeolithic occupations and Neanderthal remains of this cave are not as young as previously thought (Barroso, 2003). All these data, and those of the caves of Gibraltar (Finlayson et al., 2006; Zilhão and Pettitt, 2006), indicate that the chronological scenario of the Southern Iberian Peninsula is far from clear. It should be also stressed that the purported survival of Neanderthals in other European regions is not supported by recent radiocarbon dates (Pinhasi et al., 2011).

Consequently, alternative interpretations to the "Ebro Frontier" hypothesis have also been proposed:

- Environmental changes. The extinction of the Neanderthals and the arrival of AMH were independent processes (Finlayson, 2004; Finlayson et al., 2004; this is a response to the model proposed by d'Errico and Sánchez-Goñi, 2003). The Neanderthals went extinct as a result of environmental changes before the settlement of modern humans in Southern Iberia.
- Gradual advance of modern human populations from Northern to Southern Iberia, causing the gradual retreat of the Neanderthals (Vega et al., 1999; Utrilla et al., 2004).
- Regional contemporaneity of Neanderthals and AMH, in both Northern and Southern Iberia (Utrilla and Montes, 1993; Maroto et al., 1996; Carbonell et al., 2000; Baena et al., 2005).
- Mosaic of different situations on a peninsular scale, which include the above-mentioned theories (Straus, 1996, 2005).
- Technological and cultural continuity between the Middle and Upper Palaeolithic (Cabrera and Bernaldo de Quirós, 1990; Cabrera et al., 2001; Sáenz de Buruaga, 1991, 2004). According to this hypothesis, the Aurignacian emerged as a local evolution from the Mousterian.

For a critical view of these interpretations and their consequences for the scenario of the encounter between the Neanderthals and AMH, three kinds of data should be discussed.

1.1. Archaeological data

In the context of this paper (pertaining to Northern Iberia), the archaeological standpoints are based on the following premises: 1) Middle Palaeolithic techno-complexes were produced by Neanderthals. The assemblages defined as Chatelperronian call for individual analysis and can sometimes be considered a specific facies of the late Mousterian. 2) The Upper Palaeolithic was the product of AMH. 3) The authors think that there is no reliable evidence suggesting a local transition between Middle and Upper Palaeolithic techno-complexes in Northern Iberia.

1.2. Chronological data

The vast majority of numerical determinations from the Iberian Middle to Upper Palaeolithic transition are radiocarbon. The accuracy of this method has been strongly questioned over the last decade as it has become increasingly apparent that routine radiocarbon pre-treatment methods do not always fully remove contaminants. Due to the exponential nature of radiocarbon decay, young contaminants have the most significant impact on radiocarbon dates, and the dates of many samples of Palaeolithic age are underestimated. This problem affects all sample types, including bone and charcoal, which are those most commonly dated. For example, direct dates on the Neanderthal remains from El Sidrón range in age from 10,340 ± 70 to 49,200 ± 2500 ^{14}C BP despite strong indications that the assemblage was deposited simultaneously (Torres et al., 2010). In the light of these concerns, the published dates from this period must be viewed with caution. In particular, the chronologies of the latest Middle Palaeolithic assemblages of Northern and Southern Iberia must be tested. New treatments in the removal of contaminants open new perspectives on this issue and allow solving the problems aroused from some aberrant dates (i.e. Higham et al., 2009).

Numerous radiocarbon pre-treatment methods exist to clean bone and charcoal prior to ^{14}C measurement, and it is widely acknowledged that some are more effective at removing contaminants that others. For example, the majority of AMS laboratories including Groningen extract collagen from bone using the traditional improved Longin method. Oxford Radiocarbon Accelerator Unit (ORAU) follows a similar protocol, but adds an ultrafiltration stage to remove the smallest contaminants from the collagen. This technique often causes dates that are not only older, but stratigraphically and archaeologically more acceptable (Higham et al., 2006; Jacobi and Higham, 2008). However, there is some debate surrounding the effectiveness of this method (Hüls et al., 2009), and several examples exist where the improved Longin method and ultrafiltration method produce identical ages, for example at Spy (Semal et al., 2009; Crevecoeur et al., 2010). It seems that when bones are well preserved both methods produce similar ages. However, when bones are degraded, ultrafiltration does appear to remove contaminants present in the collagen.

From a chemical point of view, charcoal is often regarded as an excellent sample type for radiocarbon as in addition to its high carbon content, it is often thought to be resistant to digenesis. However, charcoal is readily oxidised to compounds that resemble humic acids when buried (Haumaier and Zech, 1995), and adsorbs a wide range of organic molecules (Zackrisson et al., 1996; Schmidt and Noack, 2000; Cornelissen et al., 2005). For radiocarbon, charcoal has traditionally been pre-treated using a simple Acid-Base-Acid (ABA) protocol. Bird et al. (1999) developed a more rigorous method, Acid-Base-Oxidation-Stepped-Combustion (ABOx-SC). When applied to charcoal > c.30 ka BP, this method often produces older ages than the ABA protocol (for example in Europe Higham et al., 2009; Douka et al., 2010) that are in stratigraphic order, and is therefore regarded as more reliable.

1.3. Geographical data

The distribution of the latest Middle Palaeolithic and the early Upper Palaeolithic should be analysed according to the variability of ecosystems existing at each geographical setting, and not only according to a latitudinal gradient. Discussion of this question should take into account not only the distribution at the late Middle Palaeolithic and early Upper Palaeolithic sites, but also the population dynamics of each area during the Upper Palaeolithic. Concerning the geographical setting of these occurrences in Northern Iberia, the following points should be stressed:

1. The first Upper Palaeolithic assemblages tend to appear in lowland areas, along the main E–W or N–S natural corridors, which suggests a strong dependence on mobility patterns. Most of these sites exhibit thick Middle Palaeolithic sequences (Arbreda, El Castillo, Covalejos, Peña Miel, Romaní, La Viña) and a continuity of occupation during subsequent stages of the Upper Palaeolithic (Arbreda, El Castillo, Reclau Viver, La Viña). Therefore, at these sites it can be said that Middle Palaeolithic populations were replaced by Upper Palaeolithic ones.
2. The latest Middle Palaeolithic assemblages dated to after 40 ka BP tend to appear in inland areas, at higher altitudes and in or near mountain landscapes. Above these latest Mousterian levels, the Upper Palaeolithic occupations are rare or entirely absent. In fact, most of these inland areas suggest a long occupational hiatus and were not significantly reoccupied until the later stages of the Upper Palaeolithic. In these inland regions there does not seem to have been an authentic replacement, and the Neanderthal extinction cannot be explained by the pressure of Upper Palaeolithic populations.
3. One of the assumptions of the "Ebro Frontier" hypothesis is that Neanderthals were better adapted to the temperate conditions of the southern areas, whereas AMH stayed in the north because of their successful adaptation to colder, steppe-like environments. The geographical distribution cited above might be taken to suggest exactly the contrary, with the latest Neanderthals inhabiting the harshest environments.

Given this situation, some years ago the need to redate the sites of the Iberian Peninsula relevant to this issue, specifically those in the northern part of the peninsula, was recognized. Within this geographical context a program of radiocarbon dating began, although the approaches set forth related to the Iberian Peninsula as a whole (Maroto et al., 2005; Vaquero et al., 2006). This paper presents for the first time the initial results obtained in the course of this program. Attention will be focused on the latest Middle Palaeolithic of Northern Iberia, although some early Upper Palaeolithic assemblages were also dated.

2. Materials and methods

Ten sites have at present been dated as part of this project. These sites were selected because they have late Middle Palaeolithic and/or early Upper Palaeolithic levels. The different regions of Northern Iberia are represented, although most sites correspond to the Cantabrian and Mediterranean regions (Fig. 1). However, the aim is to enlarge the geographical scope of the project in the near future, incorporating more sites from Galicia, the Northern Meseta, and the Ebro Valley. Among others, the following sites will be included: A Valiña (Galicia), Conde (Asturias), Cobrante (Voto, Cantabria), Axlor (Dima, Basque Country), Labeko Koba (Arrasate, Basque Country), Prado Vargas (Castile and León), Peña Miel (La Rioja), and Abric Romaní (Capellades, Catalonia). Among the dated sites, three different situations can be differentiated:

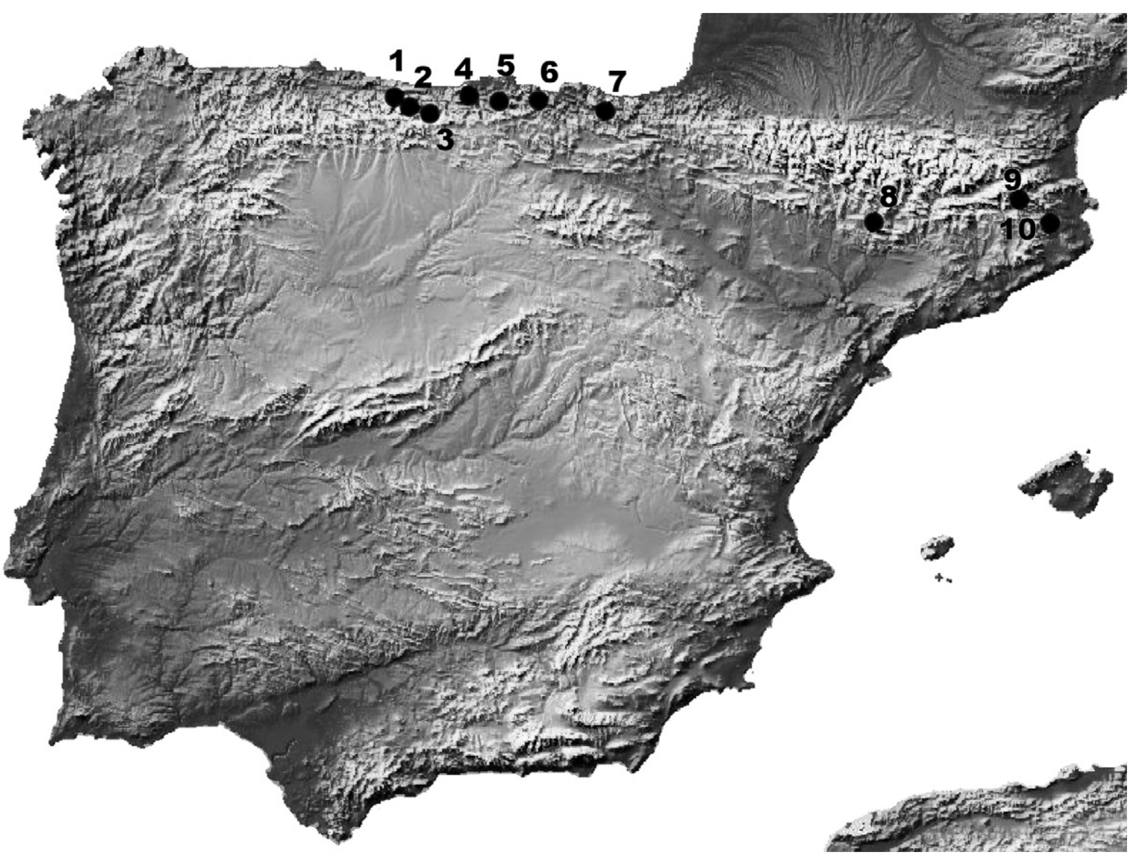

Fig. 1. Map of the Iberian Peninsula, indicating the sites dated for this paper. 1: La Güelga. 2: Sopeña. 3: El Esquilleu. 4: Covalejos. 5: Morín. 6: El Cuco. 7: Lezetxiki. 8: Fuentes de San Cristóbal. 9: Ermitons. 10: Arbreda.

a) Sites with previous data indicating a recent age for Mousterian assemblages: El Esquilleu (Castro-Cillórigo, Cantabria), Fuentes de San Cristobal (Veracruz, Aragon), La Güelga (Cangas de Onís, Asturias), and Ermitons (Sales de Llierca, Catalonia).
b) Recently excavated sites with late Middle Palaeolithic and/or early Upper Palaeolithic levels: Covalejos (Piélagos, Cantabria), El Cuco (Castro Urdiales, Cantabria), and Sopeña (Asturias).
c) Classic sites with late Middle Palaeolithic and early Upper Palaeolithic levels: Arbreda (Serinyà, Catalonia), Morín (Villanueva de Villaescusa, Cantabria), and Lezetxiki (Arrasate, Basque Country).

An attempt was made to date a Mousterian site without previous dates but considered to be possibly of a recent age: Mig Cave (Cornellà de Conflent, Catalonia), in this case situated to the north of the Pyrenees (Blaize, 1986).

The sites which received the greatest attention are the Mousterian ones that previously presented a relatively recent date. The case of El Esquilleu Cave is the most singular because it presents *a priori* a long sequence of latest Middle Palaeolithic levels, and had yielded some surprisingly recent dates for the uppermost layers, which were attributed to the Mousterian according to both technological and typological criteria (Baena et al., 2005). Level XIF and VIF were previously dated respectively to 36,500 ± 830 and 34,380 ± 670 ^{14}C BP. However, the most recent date corresponds to level IV (22,840 + 280/−250 and 23,560 ± 120 ^{14}C BP). The dates for level IV seem aberrant even for the recent Middle Palaeolithic and are younger than those from the purported final Middle Palaeolithic assemblages of Southern Iberia. A detailed account of the Esquilleu dates can be seen in Baena et al. 2011.

La Güelga Cave was known especially for its Magdalenian layers. However, excavation of a new area has recently started, showing a sequence comprising Aurignacian, Châtelperronian and Mousterian levels (Menéndez et al., 2005). A bone sample from the Mousterian assemblage yielded a conventional radiocarbon date of 32,000 + 1600/−1350 ^{14}C BP. The presumed Châtelperronian levels were dated to between 32,460 ± 440 and 29,020 ± 260 ^{14}C BP.

Las Fuentes de San Cristóbal showed a thick stratigraphic sequence with very rich basal Mousterian layers. However, the archaeological horizons overlying these Mousterian levels are poor and largely undiagnostic. The radiocarbon dating available to date (36,000 ± 1900 ^{14}C BP) corresponded to level P, attributed to the Middle Palaeolithic on the basis of the presence of an alleged Mousterian point (Rosell et al., 2000). In this context, it seemed advisable to date the clearly Mousterian assemblages from the bottom of the sequence. The new dates correspond to charcoals from carbonaceous areas interpreted as remnants of combustion structures.

For Mousterian level IV of Ermitons Cave, two ^{14}C dates have so far been available: a conventional date of 36,400 ± 1800 ^{14}C BP and an AMS date of 33,190 ± 660 ^{14}C BP. This level is characterized by the high impact of carnivores – especially cave bears – although the human presence is also important and its lithic assemblage diagnostic (Maroto et al., 1996). Additional dating was needed in order to clarify the discrepancy between the previous dates and especially to confirm the result of the AMS dating.

Three recently excavated sites (Covalejos, Sopeña and El Cuco) from the Cantabrian region with late Middle and/or early Upper Palaeolithic assemblages have been dated in this project. The excavations carried out in Covalejos Cave between 1997 and 2002 yielded a Mousterian sequence in which the uppermost layer (level D) was dated to 40,650 + 2300/−1800 and 41,640 + 650/−530 ^{14}C BP. This level was overlaid by an Aurignacian layer (level C) dated to 32,840 + 280/−250 ^{14}C BP (Sanguino and Montes, 2005).

The Rock Shelter of Sopeña has also recently provided a sequence with late Middle and early Upper Palaeolithic levels. The most ancient Upper Palaeolithic level (level XI) was dated to 32,870 ± 530 ^{14}C BP, while the top of the Middle Palaeolithic sequence (level XII) yielded a date of 38,630 ± 800 ^{14}C BP (Pinto-Llona et al., 2005, 2009).

Unlike the rest of the sites, the test pit excavated in 2005 in El Cuco Rock Shelter revealed an Upper Palaeolithic sequence, showing both Gravettian and Aurignacian levels (Muñoz et al., 2007).

Three classic sites characterized by thick stratigraphic sequences and a long history of research were also dated. First, Morín Cave has a well-known sequence including Mousterian, Châtelperronian, and Aurignacian levels, although the reliability of this sequence has been the subject of some debate (Sanguino et al., 2005). Prior to this dating, the top of the Mousterian (level 11) was dated to 39,770 ± 730 ^{14}C BP, while the Châtelperronian level (level 10) yielded two dates: 36,950 ± 6580 and 28,610 ± 560 ^{14}C BP. Finally, the Aurignacian from level 8 was dated to 36,590 ± 707 ^{14}C BP (Stuckenrath, 1978; Maíllo et al., 2001).

The Lezetxiki Cave sequence is composed of Middle and Upper Pleistocene layers, including some levels corresponding to the time range of the Middle/Upper Palaeolithic boundary. However, there have been some doubts about the cultural attribution of the assemblages from the old excavations. New excavations started in 1996 (Arrizabalaga, 2005, 2006; Arrizabalaga et al., 2005) with the aim of clarifying the cultural sequence and its chronology, but the datings attempted so far have not been successful (Falgueres et al., 2006). Dating samples from level III were selected in 1991 from bones from the classic excavation. Level III presents a steep slope and is divided into two sublevels: IIIa and IIIb. Sublevel IIIa contained industry and fauna; sublevel IIIb, only fauna. The authors think that during the excavation the bones from IIIa and IIIb were not properly separated (the two subunits are very similar sedimentologically). The hypothesis is that IIIa is Aurignacian (with human activity) and IIIb is Middle Palaeolithic (bones provided by carnivores).

Finally, Arbreda Cave is one of the key sites in this debate, since the Archaic Aurignacian level (H) has provided some of the oldest Aurignacian dates from the Iberian Peninsula (between 35,480 ± 820 and 39,900 ± 1300 ^{14}C BP). Underlying the basal Aurignacian, there is a late Middle Palaeolithic level (level I) that was also dated (between 34,100 ± 800 and 44,560 ± 2400 ^{14}C BP) (Maroto et al., 1996). However, the date available for the Evolved Aurignacian (level G) was imprecise (>28,800 ^{14}C BP) (Sacchi et al., 1996).

Some data concerning the nature and quality of the dated samples have been assembled in Table 1. The samples have been selected according to certain basic criteria. First, a precise stratigraphic context was a primary concern. Except in the case of Lezetxiki, all the samples were taken during recent or ongoing excavations, and the stratigraphic context of these samples was well defined. The materials from the ongoing excavations at Lezetxiki were not available and the dated samples correspond to the classic excavations (1966) by J.M. Barandiarán. The samples from El Cuco, Ermitons, El Esquilleu, La Güelga, and Morín were taken directly in the field specifically for this project. In Morín, samples were taken from the sections left by old excavations. All the samples were microscopically analysed in order to preclude the presence of *hyphae*. In addition, the humidity conditions were controlled during the storage of the samples.

However, information is lacking about the presence of cutmarks or anthropogenic fractures for most of the bone samples. Although most samples come from archaeological levels in which human activity is dominant, there is abundant evidence of

Table 1
Nature and contextual information of the samples selected for dating.

Site	Level	Culture	Sample and ref. lab.	Determination	Archaeological context	Sampling context	Sampling date
Arbreda	G	Evolved Aurignacian	Charcoal (OxA-19935)	*Prunus*	Archaeological level	Extensive excavation	Prior to this project (1987)
Arbreda	I	Mousterian	Charcoal (OxA-19994)	*Pinus* type *sylvestris*	Archaeological remains and carnivore activity	Extensive excavation	Prior to this project (1987)
Covalejos	C	Archaic Aurignacian	Tooth (GrA-33877)		Archaeological level	Test pit	Prior to this project (2002)
Covalejos	D	Mousterian	Tooth (GrA-33811)		Archaeological level	Test pit	Prior to this project (2002)
Covalejos	I	Mousterian	Tooth (GrA-33822)		Archaeological level	Test pit	Prior to this project (2002)
Covalejos	J	Mousterian	Tooth (GrA-33812)	*Cervus elaphus*	Archaeological level, fire	Test pit	Prior to this project (2002)
Cuco	XIII	Evolved Aurignacian	Burned bone (GrA-32436)	Indeterminable	Archaeological level	Test pit	This project
Ermitons	IV	Mousterian	Tooth (GrA-33813) Tooth (GrA-33814) Charcoal (OxA-19932)	*Capra pyrenaica* *Ursus spelaeus* *Quercus* sp. (evergreen)	Archaeological remains and carnivore activity	Extensive excavation	This project
Esquilleu	III	Mousterian	Bone (OxA-19967, 68) Charcoal (GrA-33829)	Indeterminable	Archaeological level	Test pit	This project
Esquilleu	III B	Mousterian	Bone (OxA-19246)	Indeterminable	Archaeological level	Test pit	This project
Esquilleu	IV	Mousterian	Charcoal (GrA-35064)		Archaeological level	Test pit	This project
Esquilleu	V	Mousterian	Charcoal (GrA-35065)		Archaeological level	Test pit	This project
Esquilleu	VI	Mousterian	Bone (OxA-19965, 66) Charcoal (GrA-33816)	Indeterminable	Archaeological level	Test pit	This project Prior to this project (1997)
Esquilleu	XVII	Mousterian	Charcoal (OxA-20318) Charcoal (OxA-20319) Charcoal (OxA-X-2297–31, 20320) Charcoal (OxA-19993)	Indeterminable *Pinus* type *sylvestris* *Pinus* type *sylvestris*	Archaeological level	Test pit	Prior to this project (2003)
Esquilleu	XIX	Mousterian	Charcoal (OxA-19085, 86, V-2284–29, 30)	*Pinus* type *sylvestris*	Archaeological level	Test pit	Prior to this project (2003)
Esquilleu	XXI-I	Mousterian	Charcoal (OxA-20321)		Archaeological level	Test pit	Prior to this project (2003)
Fuentes de San Cristóbal	E	Mousterian	Charcoal (OxA-19145)	Conifer	Archaeological level, hearth	Extensive excavation	Prior to this project (1998)
Fuentes de San Cristóbal	F	Mousterian	Charcoal (GrA-33817) Charcoal (GrA-33904)	*Pinus* type *sylvestris* *Pinus* type *sylvestris*	Archaeological level, hearth	Extensive excavation	Prior to this project (1999, 2001)
Fuentes de San Cristóbal	G	Mousterian	Charcoal (OxA-19933) Charcoal (OxA-19934)	*Pinus* type *sylvestris* *Pinus* type *sylvestris*	Archaeological level, hearth	Extensive excavation	Prior to this project (2002)
Güelga	9	Mousterian	Bone (OxA-19244, 45)	Indeterminable	Archaeological level	Extensive excavation	This project
Lezetxiki	III	Aurignacian/ Mousterian	Bone (OxA-21837) Bone (OxA-22021) Bone (OxA-21838) Bone (OxA-21715) Bone (OxA-22627)	Ungulate Ungulate Ungulate Ungulate Ungulate	Archaeological level (upper unit)/archaeological remains and carnivore activity (lower unit)	Ancient excavation	Prior to this project (1966–68)
Morín	8	Archaic Aurignacian	Charcoal (OxA-19084)	Indeterminable	Archaeological level	Profile from ancient excavation	This project
Morín	9	Archaic Aurignacian	Charcoal (GrA-33891)		Archaeological level	Profile from ancient excavation	This project
Morín	10	Chatelperronian	Charcoal (GrA-33823)		Archaeological level	Profile from ancient excavation	This project
Morín	11	Mousterian	Charcoal (OxA-19083, 19459)	*Betula*	Archaeological level	Profile from ancient excavation	This project
Sopeña	XI	Aurignacian	Bone (GrA-39760)	Indeterminable	Archaeological level	Test pit	Prior to this project (2002)
Sopeña	XII	Mousterian	Bone (GrA-39761)	Indeterminable	Archaeological level	Test pit	Prior to this project (2002)

carnivore activity in some cases (Arbreda I, Ermitons IV and Lezetxiki IIIb). In these assemblages, correlation between radiocarbon dates and cultural remains is particularly problematic. In level I of Arbreda, the selected sample is a single pine charcoal whose association with the artefactual evidence is uncertain. In Ermitons IV, one of the faunal samples (a tooth of *Ursus spelaeus*) is clearly unrelated to the human occupations and the second one (a tooth of *Capra pyrenaica*) may correspond to both human and carnivore activity. This is also the case of the ungulate bone splinters dated in Lezetxiki IIIb.

When available, charcoal samples from hearths were preferred for dating, but this was only possible in Las Fuentes de San Cristobal. Most charcoals have been taxonomically identified before dating, in order to avoid the inclusion of typically Holocene species.

At the ORAU, bone samples were treated with the ultrafiltration protocol (Bronk Ramsey et al., 2004; Brock et al., 2010). After carbonates are removed with a gentle HCl treatment (0.5 M, c. 18 h, room temperature (RT)), alkali soluble organics are removed with NaOH (0.1 M, 30 min, RT) and dissolved carbon dioxide is removed with HCl (0.5 M, 15 min, RT). The insoluble collagen is gelatinised by heating to 75 °C for 20 h in pH3 water, and insoluble contaminants removed with a 60–90 μm Eezi™ filter. The gelatin solution is subsequently ultrafiltered using a pre-cleaned 30 kDa MWCO Vivaspin™ VS15 ultrafilter.

The majority of charcoal samples were cleaned using the ABOx-SC protocol (Brock et al., 2010), where acid (6 M HCl, 1 h, RT) and alkali (2 M NaOH, 30 min, RT) washes are followed by oxidation in acidified potassium dichromate (2 M H_2SO_4/0.1 M $K_2Cr_2O_7$, 20 h, 60 °C) and pre-combustion (630 °C for 2 h in the presence of copper oxide wire). Several samples were also pre-treated with a routine acid-base-acid protocol (1 M HCl for 20 min, 0.2 M NaOH for 30 min, 1 M HCl for 1 h, all at 80 °C) to establish whether the more destructive ABOx-SC protocol was required at the sites examined.

All samples were freeze-dried prior to combustion. Gas samples were graphitised and measured in an AMS as described in Brock et al. (2010).

In Groningen, the sample underwent standard chemical cleaning and collagen extraction, following Longin (1971). The collagen was combusted to CO_2. The CO_2 was cryogenically trapped using an automatic device (Aerts et al., 2001), transformed into graphite, and analysed for ^{14}C by AMS (van der Plicht et al., 2000).

The ^{14}C activities were measured relative to a standard radioactivity, corrected for isotopic fractionation using the stable isotope ratio $^{13}C/^{12}C$ to $^{13}C = -25‰$, calculated using the conventional half-life, and reported in BP (Mook and van der Plicht, 1999).

Since 2009, the ^{14}C dates can now be calibrated for the complete dating range. Radiocarbon dates have been calibrated using the IntCal09 curve (Reimer et al., 2009) using the OxCal version 4.1 software (Bronk Ramsey, 2009). For the Palaeolithic period, the calibration curve is derived from marine records and uncertainties, for example those surrounding reservoir effects, exist. However, such offsets are likely to be several hundred years in magnitude (e.g. Hua et al., 2009) and are therefore unlikely to significantly influence the chronology discussed here.

3. Results

The results of this first dating program can be seen in Table 2. At present, 71 samples have been submitted for dating. Twenty-three did not produce results due to a lack of collagen or some other defect. Mig Cave is the only site that could not be dated. Therefore, there are 48 new ^{14}C dates (31 carried out in the Oxford laboratory and 17 in the Groningen laboratory), 38 of which are considered consistent (albeit with reservations in some cases) because they fit in the chronological range expected for their respective archaeological assemblages. However, 10 dates are considered to be problematic, as they are anomalous given their cultural association. Two of them (878 ± 28 ^{14}C BP from Ermitons level IV and 3640 ± 90 ^{14}C BP from El Esquilleu level III) can be explained by intrusion of the levels in question by Holocene charcoals. The charcoal sample from Ermitons was identified as evergreen *Quercus* sp., and the anomalous date tends to corroborate that this taxon is rare in charcoal assemblages of the Catalan Upper Pleistocene. The rest of the anomalous dates deserve further discussion on a case-by-case basis. Micro-mixing cannot be excluded as a possible explanation for these anomalies, although other possible causes must also be scrutinized. The process of analysing a minimum of 40 further samples is ongoing, and this number is anticipated to increase in the near future. Three U/Th dates were also obtained from Ermitons level VI (Table 3).

Samples from Middle Palaeolithic layers at Arbreda, Covalejos, Ermitons, El Esquilleu, Fuentes de San Cristobal, La Güelga, Morín and Sopeña have been dated. Only in level XII of Sopeña has this work produced a date (35,500 + 650/−460 ^{14}C BP) that is younger than previously published dates for the same layer (38,630 ± 800 ^{14}C BP). The results from other sites tend to corroborate the ages estimated previously according to the earlier dating, since the new dates are similar or a little older. The uppermost Mousterian layer of Arbreda has been dated to 38,350 ± 400 ^{14}C BP, within the time span defined by the dates previously available for this level, although it also clearly overlaps with some dates from the overlying Archaic Aurignacian level. Likewise, the new date for the uppermost Mousterian of Covalejos (43,050 + 750/−550 ^{14}C BP) is only slightly older than the already published dates for this layer. The date of the tooth sample from level I (30,860 + 340/−300 ^{14}C BP) should be considered invalid, since it seems too recent for a Mousterian level and is at odds with the rest of the dates available for this sequence. This date has a relatively low %C (32.7%), and is less reliable that the others. The two dates for level 11 of Morín Cave (41,800 ± 450 and 43,600 ± 600 ^{14}C BP) are also slightly older than the date previously yielded by this layer. The ABOx-SC date is marginally, but statistically significantly older (chi squared test fails at 5%: df 1, $T = 6.01$, $5\% = 3.8$). Therefore, ABA dates from this site would be expected to be underestimations. The most consistent results have been obtained at levels E-G of Fuentes de San Cristóbal, which have yielded five radiocarbon dates ranging from 36,200 ± 350 to 39,290 + 490/−410 ^{14}C BP.

In two other sites, the new dates are also older, but the difference with respect to the former dating is more important. This is the case with the two dates from level IV of Ermitons (40,580 + 550/−470 and >45,000 ^{14}C BP), which are markedly older than the previous dates, especially the AMS date of 33,190 ± 660 ^{14}C BP, which was considered the most reliable. The infinite date is the most reliable as GrA-33813 has a slightly low %C 28.8. On the other hand, the U/Th results for level VI indicate that its age is much earlier (ca. 103 ka) and vindicate the negative ^{14}C tests. Something similar happens in La Güelga, where the two new results from a single sample (43,700 ± 800 and 44,300 ± 1200 ^{14}C BP) are more than 10 ka older than the date of 32,000 + 1600/−1350 ^{14}C BP previously published for the Middle Palaeolithic deposit of this site. Dates are older probably because of the application of the ultrafiltration protocol.

El Esquilleu Cave is the site that has provided most dates for Mousterian layers and exhibits a particularly complex dating pattern. From a chronological point of view, two different ensembles should be distinguished in the stratigraphy. From level VI downwards, the new dates lie in the temporal range typical for the Middle Palaeolithic of Northern Iberia. In some levels, they are appreciably older than the previously available dates. This is the case with level VI, which has been dated to between 40,110 + 500/−420 and 44,100 ± 1300 ^{14}C BP, in contrast to the younger date previously published for this layer (34,380 ± 670 ^{14}C BP). The stratigraphic consistency of some dates is far from perfect, especially the three dates around 39 ka ^{14}C BP from level XIX, which seem too young given the dates obtained for the whole sequence. It should be stressed that these three dates correspond to a single sample and were obtained using the ABA and PO treatment methods. Another fraction from the same sample treated using the ABOx-SC method gave an older result of >54,600 ^{14}C BP. This supports the conclusion that the ABOx-SC method removes contamination more effectively than other methods and yields therefore older results. However, the most astonishing results are

Table 2

Radiocarbon accelerator dates presented in this work. Treatment Codes: ABA, a charcoal fragment treated with a series of acid and base washes; ABOx-SC, charcoal treated with acid and base washes, followed by an oxidation stage and pre-combustion; UF, collagen extracted using the ultrafiltration protocol; PO, plasma oxidation, which is an experimental technique (Bird et al., 2010). L: Longin (improved) for bone collagen extraction; C: apatite (carbonate fraction); A: acid only (samples too delicate for full ABA). Various coarse indicators of sample quality are given. %C of charcoal of fresh charcoal ranges between 50 and 70% (Braadbaart et al., 2009), and the %C on bone is around 40% (Van Klinken, 1999). $\delta^{13}C$ of charcoal should range between −26 and −22‰ whilst bone of terrestrial herbivores should fall between −22 and - 18‰ (Van Klinken, 1999). For bone collagen, %N should fall between 11 and 16%, $\delta^{15}N$ 2–12 and the C:N ratio between 2.9 and 3.4 (Van Klinken, 1999). % yield provides an indication of preservation, and is particularly important for bone where the collagen yield should be >1% the starting bone weight (Van Klinken, 1999).

Site	Level	Lab Code	Radiocarbon Date (Years BP)	1 Sigma Calibrated Date BP (68,2% probability)	2 Sigma Calibrated Date BP (95,4% probability)	%C	$\Delta^{13}c$	%N	$\Delta^{15}n$	C : N	% Yield	Treatment
Arbreda	G	OxA-19935	30,950 ± 220	36,193–35,053	36,285–34,936	64.7	−24.1				14.7	ABA
Arbreda	I	OxA-19994	38,350 ± 400	43,067–42,432	43,417–42,115	39.6	−24.5				11.9	ABOX-SC
Covalejos	C	GrA-33877	37,940 + 400 − 350	42,636–42,311	42,800–42,136	37.0	−20.6					L
Covalejos	D	GrA-33811	43,050 + 750 − 550	46,272–45,798	46,519–45,565	36.9	−20.8					L
Covalejos	I	GrA-33822	30,860 + 340 − 300	36,110–34,998	36,198–34,931	32.7	−21.4					L
Covalejos	J	GrA-33812	>45,000			39.1	−20.8					L
Cuco	XIII	GrA-32436	30,020 + 160 − 150	34,776–34,614	34,879–34,531							C
Ermitons	IV	GrA-33813	40,580 + 550 − 470	44,595–44,276	44,763–44,144	28.8	−19.1					L
Ermitons	IV	GrA-33814	>45,000			42.1	−21.6	14.0	5.92	3.5		L
Ermitons	IV	OxA-19932	878 ± 28	892–737	906–729	65.1	−24.9				70.7	ABA
Esquilleu	III	OxA-19967	19,300 ± 100	23,293–22,663	23,436–22,561	46.9	−19.2	16.2	2.5	3.4	5.1	UF
		OxA-19968	19,310 ± 80	23,305–22,670	23,424–22,593	49.1	−19.4	17.0	2.1	3.4	4.8	UF
Esquilleu	III	GrA-33829	3640 ± 90	4086–3845	4232–3703	0.7	−26.3					A only
Esquilleu	III B	OxA-19246	20,810 ± 110	24,973–24,560	25,114–24,450	44.7	−19.4	15.9	4.9	3.3	2.1	UF
Esquilleu	IV	GrA-35064	22,840 + 280 − 250	27,961–27,566	28,038–26,947	15.2	−22.7					A only
Esquilleu	V	GrA-35065	30,250 + 500 − 430	34,914–34,705	35,046–34,626	49.7	−21.9					A only
Esquilleu	VI	OxA-19965	43,700 ± 1400	May extend beyond	May extend beyond	46.2	−19.1	16.0	4.0	3.4	1.3	UF
		OxA-19966	44,100 ± 1300	calibration curve	calibration curve	44.4	−19.3	15.4	3.6	3.4	1.4	UF
Esquilleu	VI	GrA-33816	40,110 + 500 − 420	44,319–43,981	44,484–43,746	60.7	−25.2					ABA
Esquilleu	XVII	OxA-20318	53,400 ± 1300	54,860–52,165	56,647–51,095	72.2	−24.5				10.3	ABOX-SC
Esquilleu	XVII	OxA-20319	>58,500			78.6	−21.7				8.0	ABOX-SC
Esquilleu	XVII	OxA-X-2297-31	49,400 ± 1300	May extend beyond	May extend beyond	36.8	−23.2				21.3	ABOX-SC
		OxA-20320	52,600 ± 1200	calibration curve	calibration curve	74.7	−23.1				15.9	ABOX-SC
Esquilleu	XVII	OxA-19993	>54,000			66.2	−22.8				1.6	ABOX-SC
Esquilleu	XIX	OxA-19085	39,280 ± 340	43,800–43,103	44,146–42,847	60.0	−23.5				10.4	ABA
		OxA-19086	>54,600	44,084–43,340	44,395–43,000	62.9	−23.0				5.0	ABOX-SC
		OxA-V-2284-29	39,600 ± 400	44,141–43,346	44,487–42,980	52.3	−23.0					PO
		OxA-V-2284-30	39,650 ± 450			49.4	−23.0					PO
Esquilleu	XXI-I	OxA-20321	> 59,600			69.9	−21.7				7.2	ABOX-SC
Fuentes de San Cristóbal	E	OxA-19145	38,650 ± 600	43,462–42,488	44,090–42,150	33.6	−22.0				4.0	ABA
Fuentes de San Cristóbal	F	GrA-33817	39,290 + 490 − 410	43,597–43,200	43,835–43,020	60.1	−24.2					ABA
Fuentes de San Cristóbal	F	GrA-33904	37,330 + 490 − 410	42,231–41,931	42,365–41,775	61.8	−24.3					ABA
Fuentes de San Cristóbal	G	OxA-19933	36,200 ± 350	41,654–41,059	41,953–40,673	63.5	−24.6				43.5	ABA
Fuentes de San Cristóbal	G	OxA-19934	38,550 ± 450	43,251–42,526	43,750–42,190	58.8	−23.4				36.7	ABA
Güelga	9	OxA-19244	43,700 ± 800	May extend beyond	May extend beyond	44.0	−19.0	15.7	5.4	3.3	2.5	UF
		OxA-19245	44,300 ± 1200	calibration curve	calibration curve	45.1	−19.0	16.1	5.4	3.3	1.7	UF
Lezetxiki	III	OxA-21837	34,550 ± 190	39,950–39,116	40,298–38,861	45.1	−19.2	15.8	5.9	3.3	4.6	UF
Lezetxiki	III	OxA-22021	29,250 ± 320	34,456–33,555	34,643–33,149	40.1	−18.2	16.5	4.7	2.9	3.0	UF
Lezetxiki	III	OxA-21838	30,830 ± 380	36,206–34,901	36,336–34,742	45.3	−18.8	15.8	4.3	3.3	5.8	UF
Lezetxiki	III	OxA-21715	>46,500			43.0	−18.8	15.0	9.6	3.4	0.6	UF
Lezetxiki	III	OxA-22627	>46,700			39.9	−22.6	14.2	3.6	3.3	1.0	UF
Morín	8	OxA-19084	40,060 ± 350	44,288–43,937	44,445–43,690	60.4	−25.5				54.4	ABA
Morín	9	GrA-33891	33,430 + 250 − 230	38,634–38,015	38,738–37,632	60.3	−24.9					ABA
Morín	10	GrA-33823	29,380 + 260 − 240	34,510–33,966	34,567–33,628	24.0	−26.1					A only
Morín	11	OxA-19083	41,800 ± 450	45,594–44,874	45,971–44,547	56.2	−25.2				25.3	ABA
		OxA-19459	43,600 ± 600	47,299–45,878	48,492–45,525	84.5	−24.2				16.7	ABOX-SC
Sopeña	XI	GrA-39760	34,470 + 650 − 430	39,573–39,018	39,998–38,874	39.0	−20.6	14.9	2.88	3.1		L
Sopeña	XII	GrA-39761	35,500 + 650 − 460	40,994–40,604	41,130–40,370	35.0	−20.5					L

Table 3

U-series radiometric data and derived dates for Ermitons Cave. The three samples come from the same stalagmite sheet. Sample 3505 is the purest and most trustworthy in age. The other two samples are contaminated (the Th-230/Th-232 ratio is low), and the ages are very probably older than they should be.

Sample	Ref-lab	U-238ppm	Th-232 ppm	U-234/U-238	Th-230/Th-232	Th-230/U-234	Nominal date (years bp)
Bottom	3505	0.47	0.05	1.08 ± 0.02	19.598 ± 0.957	0.62 ± 0.02	103,188 + 5112 − 4889
Intermediate	5308	0.55	0.37	1.06 ± 0.02	3.453 ± 0.089	0.70 ± 0.02	129,664 + 7652 − 7160
Top	5208	0.63	0.40	1.07 ± 0.02	3.325 ± 0.109	0.64 ± 0.02	109,572 + 5903 − 5606

those from the uppermost layers. These dates are stratigraphically consistent, but extraordinarily recent for Mousterian assemblages, especially those from levels III (19,300 ± 100 and 19,310 ± 80 ^{14}C BP), IIIB (20,810 ± 110 ^{14}C BP) and IV (22,840 + 280/−250 ^{14}C BP). Previous dates from these levels were 12,050 ± 130 (level III) and 23,560 ± 120 ^{14}C BP (level IV). The routinely young dates from levels III and IIIB (including dates on bone pre-treated with the ultrafiltration method) do suggest that these levels are younger than normally seen for the Mousterian. It should be noted that GrA-33829 and GrA-35064 have extremely low %C (0.7 and 15%). However, within the ABOx-SC dates reproducibility is good even where the %C is low (e.g. OxA-X-2297-31).The queries posed by these dates will deserve further attention.

Samples from Aurignacian layers have been dated at Arbreda (level G), Covalejos (level C), El Cuco (level XIII), Morín (levels 8 and 9), Sopeña (level XI), and Lezetxiki (level III). Only levels 8 and 9 of Morín and level C of Covalejos can be assigned to the Archaic Aurignacian. The rest of the levels correspond to the Evolved Aurignacian (Arbreda, El Cuco) or an indeterminate Aurignacian (Sopeña, Lezetxiki). In addition, one sample was dated from the Châtelperronian layer (level 10) of Morín. The dates from the Archaic Aurignacian of Morín are problematic, especially the result from level 8 (40,060 ± 350 ^{14}C BP), which seems a little old for an Aurignacian assemblage and is stratigraphically inconsistent with the date from the underlying level 9 (33,430 + 250/−230 ^{14}C BP). Furthermore, these dates are at odds with the previously published date from level 8. The new date from the Châtelperronian level (29,380 + 260/−240 ^{14}C BP) cannot be considered satisfactory either, since it is stratigraphically contradictory, inconsistent with the previously available date for this level and too young for a Châtelperronian assemblage. Moreover, the date from level 10 must be viewed with caution as the charcoal has a %C of only 24.0%.

The date from level C of Covalejos (37,940 + 400/−350 ^{14}C BP) is in the oldest fringe yet found for the Iberian Aurignacian, but is ca. 5 ka older than the previously published date for this layer.

On the other hand, dates from Evolved Aurignacian levels are as expected. Results from both level G of Arbreda (30,950 ± 220 ^{14}C BP) and level XIII of El Cuco (30,020 + 160/−150 ^{14}C BP) agree with the dates obtained for this type of Aurignacian assemblage at other sites.

The new date from the lowermost Upper Palaeolithic layer of Sopeña (34,470 + 650/−430 ^{14}C BP) is also older than the previous one, but the difference is smaller in this case. As for the Mousterian layer, additional dating is scheduled in order to establish a precise chronology for this level.

Finally, two dates from level III of Lezetxiki provide clearly Mousterian results (>46,500 and >46,700 ^{14}C BP), and three datings match an Aurignacian context (34,550 ± 600, 30,830 ± 380 and 29,250 ± 320 ^{14}C BP), unlike some aberrant results previously published for this layer (Falguères et al., 2006). In any case, the lower sublevels are Mousterian (the best characterized are IVa and IVc).

4. Discussion and conclusions

The overall assessment of these results is of course provisional, and they thus await verification. This has been the first series of dates obtained in the course of this research project, and it is expected that future dates will contribute to clarifying some of the controversial issues left unresolved by these preliminary results. This is particularly the case with those layers that provide inconsistent dates or dates that do not agree with the previously published dating. However, the new dates allow some general reflections to be made.

In this discussion, priority is given to the ^{14}C dates presented in this paper over the ^{14}C dating carried out in the past. There are two fundamental reasons for this. First, these readings have been recently obtained using more widely tested laboratory techniques, and more rigorous control was applied to the provenience and quality of the samples. Second, a wider-ranging discussion will appear in a forthcoming paper, considering the various archaeological interpretations and comparing the results with the dates obtained from other sites and within a broader regional context.

The early − *provisional*− indications are that the recent Mousterian of the north of the Peninsula is not as recent as thought, and is not posterior− or is only a little posterior − to the first Aurignacian, although this is relatively old. The late survival of Mousterian assemblages previously suggested by some dates has not been completely confirmed by the new data. This is particularly the case with Ermitons and La Güelga, where Mousterian layers were previously dated to ca. 32–33 ka ^{14}C BP, whereas the new radiocarbon dates for these layers are older than 40 ka BP. A recent date for the Mousterian has not been confirmed in Las Fuentes de San Cristóbal either, where the clearly Mousterian layers have yielded consistent dates between 36 and 39 ka ^{14}C BP, in agreement with those commonly obtained for the end of the Middle Palaeolithic in Europe. Leaving aside the uppermost levels of El Esquilleu, all the Mousterian assemblages have yielded dates older than 35 ka ^{14}C BP, that from layer XII of Sopeña being the youngest. Moreover, the Sopeña date should be taken with caution, since it is inconsistent with a ca. 38 ka date already published for the same layer (Pinto-Llona et al., 2009). The bone date from Sopeña cannot be interpreted until further work is undertaken to examine whether the date itself may be an underestimation. The late survival of Mousterian industries in Northern Iberia is therefore not supported by the new data. However, the dates from the Mousterian layers of Cova Gran recently published by Martínez Moreno et al. (2010) indicate that this should still be considered an open question, although these authors are reluctant to regard these dates as evidence for Mousterian survival in Northern Iberia.

The main exception to this pattern is the dates from the uppermost layers of El Esquilleu. The lithic assemblages of these layers have been characterized as Mousterian. The lithic assemblage of level III consists of 2879 artefacts. Local raw materials − mainly quartzite − are clearly dominant, and flint is practically absent. In the context of a particularly expedient technical behaviour, core reduction sequences show the dominance of discoidal methods, although some unidirectional prismatic cores have also been found. Retouched artefacts are scarce, but tool inventories are characterized by moderate frequencies of sidescrapers and denticulates (Baena and Carrión, 2002; Carrión, 2002). There is no technological or typological feature typical of Upper Palaeolithic techno-complexes. These characteristics seem at odds with the dates of around 19–22 ka ^{14}C BP obtained for levels III and IV and that of ca. 30 ka ^{14}C BP for level V. Three different explanations can be proposed for this apparent contradiction:

a) The uppermost levels of El Esquilleu represent a survival of Mousterian industries until 20–19 ka BP.
b) These assemblages correspond to an atypical Upper Palaeolithic facies.
c) The dates are unreliable due to contamination of the samples, post-depositional processes or percolation problems.

The use of different procedures in the pre-treatment of the samples for dating, and even different dating methods, do not help in clarifying the chronological context in this complicated period.

The survival of Mousterian industries until the Late Glacial Maximum is inconsistent with the regional context. Current dating, including most of the dates presented in this paper except El Esquilleu, suggests a chronology of around 39–38 ka ^{14}C BP for the end of the Mousterian in Northern Iberia. Although the date from level V could be accepted arguing a chronological pattern similar to that proposed for Southern Iberia, the dates from levels III and IV remain extremely young.

The second hypothesis does fit with the chrono-cultural sequence currently accepted for the Upper Palaeolithic in the north of the Iberian Peninsula. However, flake-based assemblages with similar dates are not unknown in other regions. For example, the Late Gravettian assemblages or Lagar Velho, dated to ca. 21–22 ka ^{14}C BP, are characterized by the dominance of expedient reduction methods aimed at the production of flakes. Artefacts diagnostic of Upper Palaeolithic industries are practically absent (Almeida et al., 2008).

Concerning the third hypothesis, dates have been obtained at different laboratories, using different pre-treatment methods. In spite of this, they are internally coherent and stratigraphically consistent. Evidence of contamination has not been detected, and the ^{13}C values indicate that the dates are accurate. Moreover, sedimentary studies indicate that the deposit was not severely affected by post-depositional disturbances (Jordá Pardo et al., 2008; Mallol et al., 2010).

Whatever the case, the results from El Esquilleu highlight the archaeological problems related to the cultural attribution of assemblages, especially concerning those characterized as Mousterian. Middle Palaeolithic assemblages are sometimes particularly undiagnostic, since they lack the fossil directors that define the Upper Palaeolithic techno-complexes. This is especially true when the core reduction methods are dominated by expedient strategies aimed at producing flakes without particular formal or dimensional features. In such technical contexts, attribution to the Middle Palaeolithic is often based exclusively on the absence of blades or typical Upper Palaeolithic tools. Since these assemblages may be the expression of an expedient technical behaviour, the existence of Upper Palaeolithic flake-based industries cannot be dismissed. In addition, interpretation should be especially cautious with small assemblages in which the absence of diagnostic Upper Palaeolithic tools may be a statistical artefact. For example, the lowermost levels of Rascaño Cave, considered Aurignacian on the basis of their stratigraphic position and two dates around 27 ka ^{14}C BP, yielded very poor and largely undiagnostic lithic assemblages, including some sidescrapers (González Echegaray, 1981). It should be stressed that some purported late Middle Palaeolithic assemblages are formed by very few artefacts, sometimes simply a handful of undiagnostic flakes. Only 103 artefacts were recovered in level IV of Gorham's Cave (Finlayson et al., 2006), 98 in level K of Caldeirao (Zilhao, 2006), and 7 in Lapa dos Furos (Zilhao, 1997).

As far as the chronology of the early Upper Palaeolithic is concerned, emphasis should be given to the date from level C of Covalejos, since this is one of the oldest dates currently available for the Archaic Aurignacian. It is similar to the date from level H of Arbreda and slightly older than the dates from Abric Romaní (Bischoff et al., 1994) and La Viña (Fortea, 1996). The dated sample was recovered in the top of the level, which minimizes the possibility of contamination from the underlying Mousterian layer. This date is older than the previously published date for this level, and more dating is needed in order to clarify the chronology of this level. Whatever the case, this new date raises the possibility that the beginning of the Aurignacian of Covalejos might be earlier than previously thought. Concerning the Early Upper Palaeolithic assemblages, the most disappointing results are those from Morín. Levels 10 to 8 have yielded a series of perfectly reversed dates, inconsistent with the stratigraphical succession and the cultural attribution of these layers. Only the date from level 9 could be considered consistent with the adscription of this layer to the Archaic Aurignacian, but the general picture offered by the Morín dates suggests using this result with caution. The sampling of old profiles exposed for 40 years could explain the problematic character of these dates. However, the chronology of the Early Upper Palaeolithic levels of Morín should be considered as uncertain until more consistent dates are available.

Dates from the Aurignacian levels of Arbreda and El Cuco are consistent with the chronology commonly accepted for the Evolved Aurignacian, although this late stage of the Aurignacian sequence has scarcely been dated in Northern Iberia. In the case of Arbreda, this is the most reliable date so far obtained for this cultural horizon. These dates are older than those obtained from the Evolved Aurignacian of Ruso I (27,620 ± 180 ^{14}C BP) and the indeterminate Aurignacian of Rascaño level 7 (27,240 + 950/−810 ^{14}C BP) – nowadays these are considered Gravettian ages – but similar to the indeterminate Aurignacian of Cobrante level 5 (30,480 ± 250 ^{14}C BP) (level 6 is 33,320 ± 310 BP) (Rasines del Río, 2009).

Thus, the early arrival of the Aurignacian on the Iberian Peninsula, prior to 37 ka ^{14}C BP, might be postulated, resulting in the relatively rapid substitution of the Neanderthals in the north of the Peninsula. A certain period of contemporaneity of the two complexes, and thus of Neanderthal and modern populations, in the north of the peninsula cannot be excluded, but only briefly on a regional scale. As pointed out by Pinhasi et al. (2011), such limited duration of the coexistence is consistent with the minor genetic contribution of Neanderthals to the genetic structure of modern Eurasians (Green et al., 2010).

As regards the method and leaving aside the problems of the sites themselves (which there are as well), the difficulties in dating this period have been confirmed. Even taking all precautions in implementing the sampling, it must be accepted that not all the results will be accurate and that various dates must be carried out on each level in order to be able to assess the results with minimum guarantees. Chronologies based on single dates should be particularly scrutinized and additional effort should be made in order to test them with more dates. This caution is especially appropriate remembering that these dates are close to the maximum range of radiocarbon dating. It should also be borne in mind that due to methodological advances in the laboratories, present-day dates are in general more significant than those carried out years ago when it comes to such old chronologies. Dates must be interpreted as minimum ages in sites which have only been dated with the traditional (ABA/Longin), experimental (PO) and gentle (A/C) pretreatments.

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