



## The Middle Paleolithic site of Cuesta de la Bajada (Teruel, Spain): a perspective on the Acheulean and Middle Paleolithic technocomplexes in Europe

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### ABSTRACT

Here we present a pluridisciplinary study of Cuesta de la Bajada site (Teruel, Spain). Our findings show that the site contains an early Middle Paleolithic assemblage similar to other European early Middle Paleolithic industries, allowing us to evaluate the coexistence of this industrial tradition with the Acheulean technocomplex in southwest Europe.

The process of lithic production at Cuesta de la Bajada represents a technology focused on debitage, the application of technical concepts such as ramified production sequences, and the recycling of flakes via the resharpening of tools and exhausted cores. This site was formed around a pond not far from a river and contains remains of large macrofauna other than equids and cervids. Taphonomic analysis highlights the abundance of cut marks on bones, and supports the hypothesis of selective hunting by hominids. The numerical ages derived from the combination of ESR, OSL and AAR dating methods indicate that the archaeological site was very likely formed around the MIS 8–MIS 9. The appearance of Middle Paleolithic industries in Europe could represent the autochthonous development of a technocomplex distinctly different from the Acheulean, characterised by *chaînes opératoires* of debitage and a progressive increase of Levallois technology and retouched tools.

These results suggest that there is a clear coexistence of assemblages with Acheulean and Middle Paleolithic industries during the last third of the Middle Pleistocene at least in the Iberian Peninsula.

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## 1. Introduction

The processes of change between the main periods of the Paleolithic have become widely researched topics over recent years. In Europe, the study of the change from the Middle Paleolithic to the Upper Paleolithic has occupied a prominent place in the literature, but a hypothetic transition from the Lower Paleolithic to the

Middle Paleolithic has also received important attention (Chazan, 2009; Villa, 2009; Richter, 2011; Moncel et al., 2012). The European Lower Paleolithic comprises archaic and Acheulean industries. Archaic industries have been defined either as Mode 1 or Oldowan (Clark, 1969), or as core and flake industries (Rocca, 2013). The European Acheulean industries show technological features in common with the African Acheulean. Shaping is dominant in the *chaîne opératoire* of these industries, and production is often oriented towards obtaining large flakes that can be used as blanks for making large tools. The elaboration of tools by retouch is not common. In contrast to the Acheulean, the aims of the knapping

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processes are different in the European archaic core-and-flake industries and in the European Middle Paleolithic. For these industries, debitage and tool elaboration by retouch are widely represented, whereas shaping is virtually absent.

In southwest Europe, lithic assemblages of cores and flake-tools of the MIS 9/MIS 5 period have traditionally been categorised as belonging to the European Ancient Middle Paleolithic (EAMP), which is distinguished from the Mousterian mainly on chronological grounds, and by some very specific technological aspects, such as the generalisation of the Levallois method (Jaubert, 1999; Delagnes et al., 2007; Villa, 2009; Scott, 2010). Here we present new evidence from Cuesta de la Bajada (Fig. 1), a site that is of direct relevance to this debate because it confirms the existence of a very ancient EAMP industrial horizon in the Iberian Peninsula (Santonja and Pérez-González, 2010). Between 1991 and 1994, a total area of 30 m<sup>2</sup> of gravel deposits were excavated from the Western Sector of the site, revealing lithic industry and fauna in non-autochthonous positions (Santonja and Pérez-González, 2001). A second area (Eastern Sector), with industry and fauna in low-energy deposits was excavated between 1999 and 2007. The results presented herein are all exclusively derived from the 73 m<sup>2</sup> excavated in this area (Figs. 2 and 3).

The evidence from Cuesta de la Bajada is discussed in relation to the Middle Pleistocene southern European Paleolithic record, including sites that have not been sufficiently considered thus far. We question the validity of the commonly held model of a transition between the Lower Paleolithic (particularly the Acheulean

techno-complex) and the Middle Paleolithic in southern and western Europe. In contrast with this theory, sometimes defined as hyper-evolutionist (Chazan, 2009), we propose an alternative hypothesis based on the independent origin of both technological traditions (i.e., the Mousterian in Europe and the Acheulean in Africa), and their coexistence and possible mutual influences across southwest Europe during the second half of the Middle Pleistocene.

## 2. Data from Cuesta de la Bajada site

### 2.1. Geology and geomorphologic framework

The Alfambra River partially drains the Neogene depression of Teruel, an extensional intermontane basin with NNE-SSW orientation that formed in the latest Middle Miocene (Godoy et al., 1983; Gutiérrez et al., 2005). In the surroundings of the city of Teruel, to the south of the Conud fault (FC-FT, Fig. 1), the following 10 fill-strath stepped terraces (with relative heights given in relation to the current river level) have been identified in the Alfambra river valley (Moissenet, 1993; Gutiérrez et al., 2005): +2–3 m (T10, present-day floodplain), +6 m (T9), +13–15 m (T8), +20–25 m (T7), +30–35 m (T6), +40–45 m (T5), +50–53 m (T4, Cuesta de la Bajada site terrace), +65–70 m (T3), +90–95 m (T2), and +103–104 m (T1). Some of these terraces (T4 and T7, Fig. 4) show syn-sedimentary thickenings caused by subsidence of the rocky substratum of Pliocene carbonates and gypsums. Though it is also possible that the process of subsidence was triggered by the neotectonic activity of the Conud-Teruel faults (Moissenet, 1993; Santonja and Pérez-González, 2001; Gutiérrez et al., 2008; Lafuente et al., 2012; Ezquerro et al., 2012).

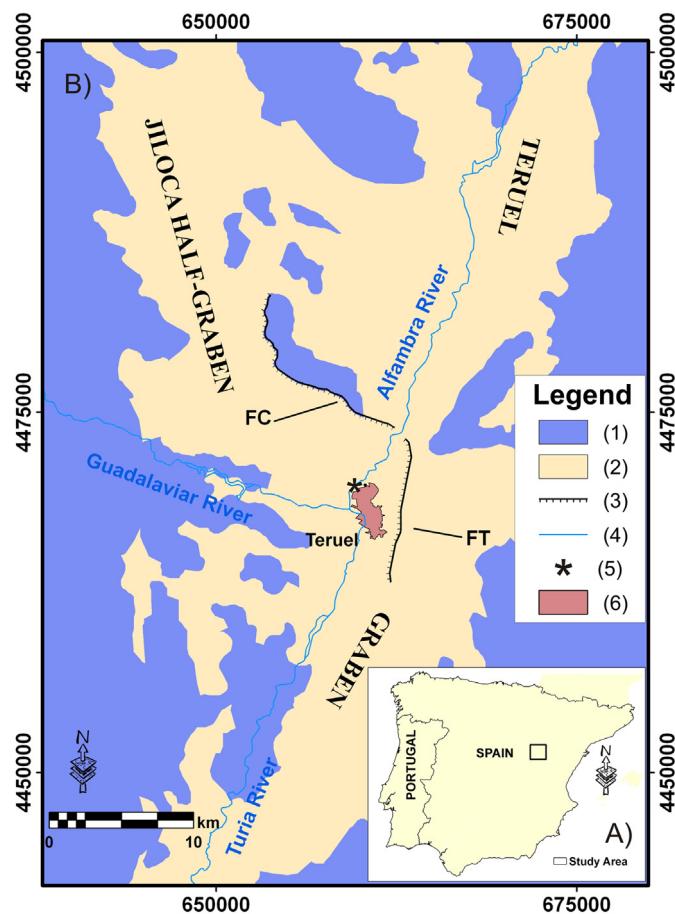
Fluvial terraces of the Alfambra valley found downstream of the Conud fault are composed of clast-supported gravels, mainly pebble size (4–62 mm) and cobble size (62–256 mm). With the exception of terraces T4 and T7, which have been subjected to syn-sedimentary subsidence and reach up to 55 m at the site of Cuesta de la Bajada (T4), the thicknesses of these deposits do not exceed 15 m. The overlap with the sandy and clayey-silt layers of the current flood plain (T10) does not allow observation of the lower section of the +20–25 m terrace (T7), which outcrops in the right margin of the Alfambra, and T4 at Cuesta de la Bajada (Fig. 4).

The lithological composition of clasts in the Alfambra river terraces is mainly carbonate and silicified gravels derived from the Middle Jurassic formations found outcropping in the watershed. However, the terraces preserved in the interfluves between the Guadalaviar and Alfambra Rivers, as well as those located downstream of the confluence with the Conud stream (Fig. 4), contain siliciclastic gravels derived from the paleozoic–mesozoic massif of Albarracín or from the Gea glacis, a topographically dominant alluvial formation which is also sourced from Albarracín and is longitudinally drained by the Conud stream.

Cuesta de la Bajada site is located about 18 m above the known base of the T4 terrace fluvial sequence. The lowermost 30 m of the T4 terrace sequence (Fig. 5) is composed of 1–2 m-thick, upward fining cycles of massive or stratified gravels (facies Gm and Gp, Miall, 1996) and floodplain mudstones (Fl) that are generally a reddish-yellow colour (7.5 YR 6/6, according to Munsell Color Companyinc, 1994).

The upper 20–25 m of the T4 terrace is composed of massive or crudely stratified gravel bars (facies Gm, Gp and Gt, Miall, 1996), with a poor presence of sandy facies and floodplain deposits. The main set of facies observed in this sequence are characteristic of gravel-dominated braided river channels (Miall, 1985), with increased sinuosity dominating in the lower part of the sequence.

At Cuesta de la Bajada the archaeological levels are associated with a small deformation depression located between a cyclic



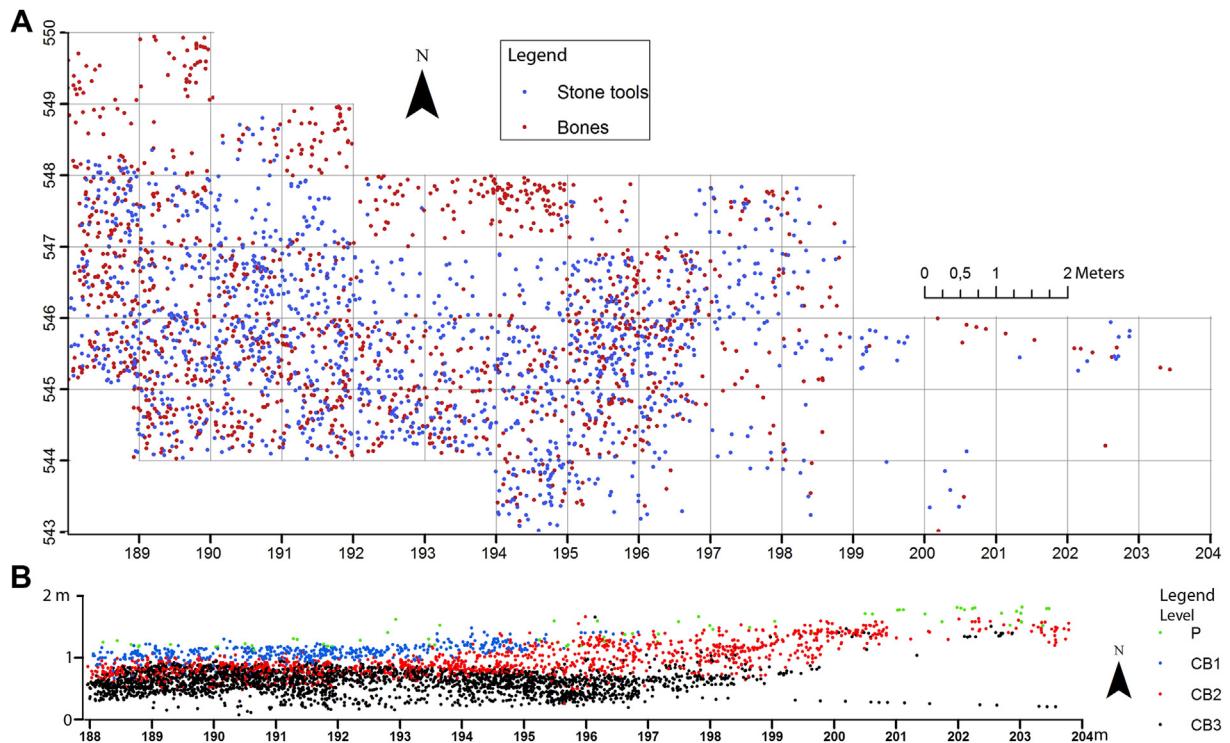
**Fig. 1.** A) Location of the study area in Spain. B) Key: (1) Mesozoic and Paleozoic of the Iberian range. (2) Neogene depressions. (3) Faults: FC (Conud); FT (Teruel). (4) Rivers. (5) Cuesta de la Bajada site. (6) Teruel city.



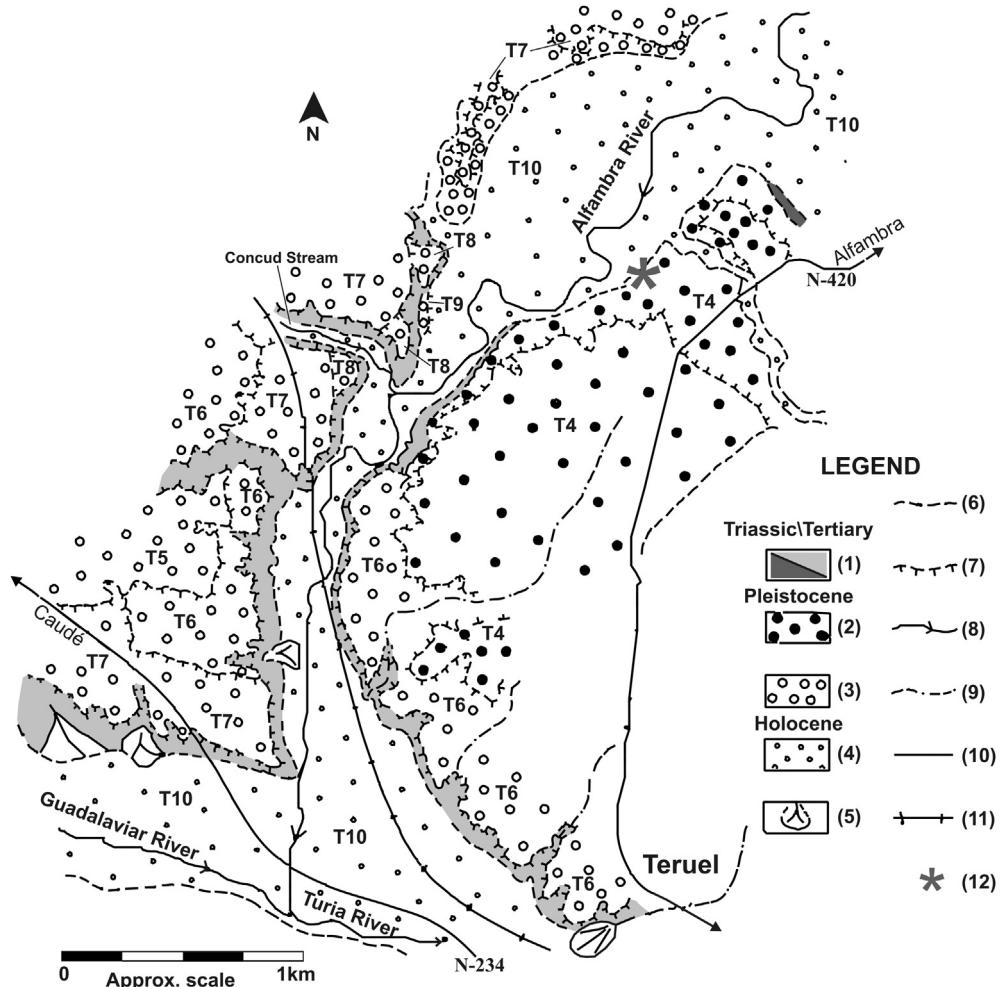
**Fig. 2.** General view of the Eastern Sector of Cuesta de la Bajada, under excavation (center of image). The accumulation of deposits that can be seen over the site corresponds to the terrace +50–53 m of the Alfambra river, whose current valley can be seen to the right.

sequence of gravel bars and floodplain muds. A lower level horizon (G) of crudely massive, sub-angular to sub-rounded pebbles is found dipping towards the NW (Fig. 5). This unit displays an irregular surface due to the development of localised fractures and ductile deformations. This level lacks any archaeological or palaeontological records.

The subsequent infill sequence of the archaeological site itself (Fig. 5) is made up of three layers covering a thickness of 1.5 m. From bottom to top, these units are denoted CB3, CB2 and CB1, with layers CB2 and CB1 displaying clearly upward fining deposits. CB3 is mainly composed of sands (50–55%) with high percentages of clay (20–25%). It also displays floating gravels of 1–2 cm diameter,



**Fig. 3.** A) General map of findings corresponding to level CB3; B) Vertical projection of the materials recovered from all the levels excavated in Cuesta de la Bajada.



**Fig. 4.** Geomorphological scheme in the proximity of Cuesta de la Bajada in Teruel. Key: (1) Clay and gypsum, Triassic/Limestone and marls, Pliocene. (2) Cuesta de la Bajada terrace, T4. (3) Alluvial terraces at +6 m, T9; +13–15 m, T8; +20–25 m, T7 (San Blas in Guadalaviar river); +30–35 m, T6 (Seminario); +40–45 m, T5. (4) Flood plain and alluvial bottoms, T10. (5) Alluvial fans. (6) Unconformities. (7) Scarp terraces. (8) Rivers and flow directions. (9) Secondary streams. (10) Roads. (11) Railroad. (12) Cuesta de la Bajada site.

which are more abundant towards the bottom of the layer. CB3 is light grey in colour (10 YR 7/1) and has a massive internal structure, though laminations can be observed at the base of the unit. CB2 is characterised by a higher presence of gravels (1–3 cm) and granules (2–4 mm) at the base, together with sands (30–40%) that become proportionally finer and very fine towards the top. The clay contents vary between 35 and 40% and the layer is grey/light grey in colour (10 YR 6.7/1). As with the underlying layer, CB2 displays large floating bones, and has a massive structure.

At the top CB2 exhibits a 1–2 cm-thick, discontinuous yellow oxidation level (10 YR 7/8) with 2–3 cm-diameter carbonate nodules. This feature represents a hiatus in the sedimentation of the site of the order of tens to hundreds of years. CB1 also comprises an upward fining sequence with a massive internal structure, and exhibits a grey colour (10 YR 5.5/1). Its texture is much finer than the underlying horizon, with granules (2–4 mm) and pebbles (1–1.5 cm) at the bottom of the unit and clays (50–55%) towards the top. Units CB3, CB2 and CB1 are capped with a 1 m-thick series of floodplain facies, denoted level P.

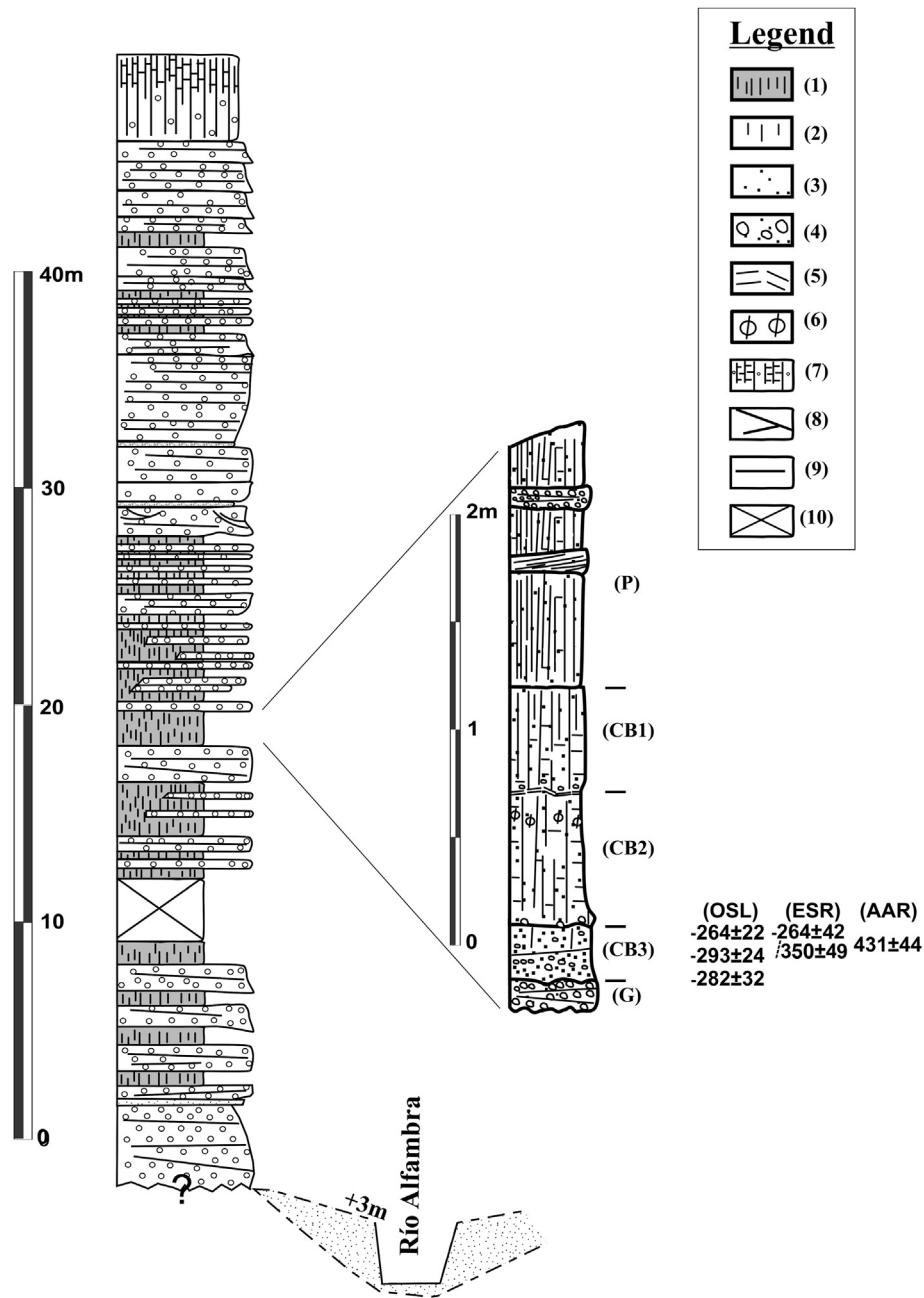
## 2.2. Chronology, biostratigraphy and taphonomy

### 2.2.1. Numerical dating

A multidisciplinary approach has been used to establish the chronology of archaeological level CB3 (Fig. 4). The single-grain OSL

ages (CENIEH samples CB10-1 and CB10-2) were derived using the approaches and instrumentation outlined in Arnold et al. (2013). The ages obtained for samples CB10-1 and CB10-2 were  $293 \pm 24$  ka and  $264 \pm 22$  ka, yielding a weighted mean age of  $278 \pm 16$  ka for unit CB3. Sample CB1 was analysed at the Laboratoire des Sciences du Climat et l'Environnement (LSCE), Gif-sur-Yvette, following the TT-OSL analytical procedure described in Sun et al. (2010). D<sub>E</sub> measurements were performed using a multiple aliquot additive-dose (MAA) protocol and dose rate components were derived from a combination of *in situ* and laboratory high resolution gamma spectrometry. A final age of  $282 \pm 32$  ka was obtained for sample CB1.

ESR dating of optically bleached quartz grains was performed at CENIEH, Burgos. The study was based on the multiple center method (Toyoda et al., 2000): both Al and Ti centers were measured and the difference in the calculated D<sub>E</sub> values derived from a multiple aliquots additive dose (MAA) procedure may suggest that the Al center was not fully bleached prior to burial. D<sub>E</sub> values were finally derived from two ESR signals associated to the Ti-centers (Duval and Guilarte, submitted for publication). Sample preparation and ESR measurements were performed as described in Duval and Guilarte (submitted). The ESR age was calculated using a non commercial SCILAB based software, with errors evaluation based on Monte Carlo simulations, and including dose rate conversion factors from Guérin et al. (2011), beta attenuations from Brennan



**Fig. 5.** Stratigraphic section of terrace T4 of the Alfambra river (see Fig. 2) and stratigraphic details of the sequences G, CB3, CB2, CB1 and P, of Cuesta de la Bajada. Note the thickening of terrace T4 due to sinsedimentary subsidence and the bottom of the terrace not being visible due to overlapping of the fluvial plain deposit of the Alfambra river. To the right of bed CB3, dates of OSL, ESR and AAR are indicated in thousands of years. The ESR age estimate –one sample– is derived from the analysis of the Ti–H center. AAR is the mean of 4 samples. Key: (1) Mud. (2) Clay and silt. (3) Sand and granule. (4) Gravel. (5) Oxidation level. (6) Carbonate concretion. (7) Colluvial and soil. (8) Cross stratification. (9) Stratification contact. (10) Covered.

(2003) and water attenuation formula from Grün (1994). Depending on the signal selected, the ESR ages obtained for sample CUB1005 collected from unit CB3 are of  $350 \pm 49$  ka and  $264 \pm 42$  ka, based either on a the combination of both Ti–Li and Ti–H centers as suggested by previous studies (e.g. Beerten et al., 2006), or on the Ti–H center only, respectively. These results, and especially the latter, are in fair agreement with the age of the OSL sample CB10-2 collected nearby (~1 m, laterally) on the same day, demonstrating the interest of using the Ti–H center to date Middle Pleistocene samples.

Amino Acid Racemization (AAR) analysis was applied of five *Equus chosaricus* teeth samples (Biomolecular Stratigraphy Laboratory of Madrid). We followed the dialysis step (3500 D) proposed by Marzin (1990) after de-mineralization of the dentine powder. The Asp D/L values obtained were introduced into the age-calculation algorithm established in Torres et al. (2000, 2003) for mammal dentine collagen. Because a single amino acid was analysed, uncertainties have not been calculated for individual age estimates. Four samples provided ages of 378; 478; 455 and 413 ka, respectively, while the last one did not contain amino acids and

therefore could not be used for dating. The combined AAR age estimate for these four samples is  $431 \pm 44$  ka, with the associated uncertainty being derived from the standard deviation of the individual age estimates.

Several other published ages exist related with the Cuesta de la Bajada sequence. Thermal ionisation mass spectrometry (TIMS) U-series dating has also been performed on tufa deposits found capping an equivalent terrace at the site of Los Baños (T4), about 2 km to the north-east of Cuesta de la Bajada. TIMS U-series ages of  $250 + 32/-25$  and  $213 + 33/-26$  ka were obtained (Gutiérrez et al., 2008). Two other alpha spectrometry U-series ages of  $169 \pm 10$  and  $116 \pm 4$  ka (Arlegui et al., 2004, 2006; Simón et al., 2005) have also been published for the same tufa deposit. All of these U-series results provide minimum age estimates for the deposition of the underlying fluvial deposits.

At the site of La Ramblilla, located 1 km away from Cuesta de la Bajada on the opposite margin of the Alfambra River, a multi-grain aliquot OSL dating of quartz (Laboratoire des Sciences du Climat et l'Environnement, Gif-sur-Yvette) of  $206 \pm 20$  ka was also obtained for terrace T7 (+20–25 m) (sample CB5, Institut de Recherche sur les Archéomatériaux, Bordeaux).

### 2.2.2. Biostratigraphy and paleolandscape

The macromammal and micromammal assemblage from Cuesta de la Bajada includes the following taxa and is also considered to be characteristic of the Middle Pleistocene: Carnivora, *Canis lupus*; Proboscidea, *Elephas (Palaeoloxodon) antiquus*; Perissodactyla, *Stenophorhinus* cf. *hemitoechus* and *E. chosaricus*; Artiodactyla, *Cervus elaphus*, *Bos primigenius*, *Rupicapra rupicapra* and *Capra* sp.; Lagomorpha, *Oryctolagus* cf. *cuniculus*; Soricomorpha, *Sorex* sp. and *Crocidura* cf. *russula*; Rodentia, *Eliomys quercinus*, *Apodemus* cf. *sylvaticus*, *Cricetulus (Allocricetus) bursae*, *Microtus breccensis*, *Microtus* cf. *duodecimcostatus* and *Arvicola* aff. *sapidus*. From a biostratigraphical point of view, the most important taxa are *A. aff. sapidus*, *M. breccensis* and *C. (Allocricetus) bursae*, for their evolved stage morphologies.

Several different types of palaeoenvironments are represented by this mammal assemblage. The abundance of horses, among other species, indicates an open landscape with the development of herbaceous vegetation and shrubs. The occurrence, albeit in low numbers, of *E. (Palaeoloxodon) antiquus* suggests the existence of some wooded areas, a transitional landscape between forest and prairie, and proximity to water. *A. aff. sapidus* lives close to watercourses with riparian vegetation; while *M. cf. duodecimcostatus* and *M. breccensis* live in wet and very wet soils, respectively.

### 2.2.3. Taphonomy

The findings of our study indicate that equids (*E. chosaricus*) dominate all three principals levels of the site (CB1, CB2 and CB3), both in terms of minimal numbers of individuals and minimal number of elements per individual; cervids (*C. elaphus*) are the second-most abundant animals. The carcasses show different qualities of preservation according to size. Intermediate-sized carcasses, which include older juvenile and adult equids, show much better preservation overall and more complete skeletal representation; small carcasses, including cervids and younger equids, are more incompletely represented and poorly preserved. In both groups, the axial skeleton is underrepresented. However, there is high survival of scapulae, pelvis and compact bones (carpal/tarsals and phalanges), suggesting that carnivores played only a moderate to marginal role in assemblage modification, depending on the level. Compact bone survival is higher for equids than for cervids, suggesting that carnivores may have played a larger role in deleting cervid bones than equid bones.

The evidences presented here shows that hominids butchered most of the carcasses in level CB3, where the best preserved assemblage from Cuesta de la Bajada was identified. Low tooth mark frequencies indicate that carnivores intervened marginally and would have had secondary access to carcasses, after hominids. The presence of some percussion marks, together with the notches and a predominance of green fractures, show that most bones at the site were broken while fresh, and likely by hominids who were seeking access to marrow. This is most clearly seen in the frequency of percussion marks in level CB3. The abundance of cut marks in level CB3 (Fig. 6) shows that hominids defleshed carcasses thoroughly. Filleting and evisceration are clearly documented by the locations of cut marks on long limb shafts and the ventral sides of ribs, respectively, but dismembering cannot be well-supported due to the virtual absence of limb epiphyses (especially well-preserved ones).

### 2.3. Lithic industry. Study of level CB3 of Cuesta de la Bajada

#### 2.3.1. General aspects

Thanks to the homogeneity of the industry observable in the three main levels of CB (Table 1), we can focus exclusively on the CB3 series, the most abundant of the three assemblages. Its technotypological characteristics can then be extrapolated to the whole of the site.

The study of the lithic industry of this level applies the notion of *chaîne opératoire* (Tixier et al., 1980; Boëda et al., 1990; Turq, 2000: 26; Bourguignon et al., 2004). Firstly, it can be observed that all phases, including ramification, are present in CB3 (Table 2). Furthermore, as we will see in detail, there is a clear connection between the proportion of cores and flakes in all knapped raw materials, with the latter showing all variants of corticality (Table 2). The presence of hammerstones and a good amount of millimetric debris also confirms the integrity of this assemblage. This is consistent with the sedimentary environment from which it was recovered.

#### 2.3.2. Acquisition phase

A total of 66 pieces (5.2% of the assemblage, excluding shatter fragments) are whole cobbles that are alien to the immediate sedimentary environment, hammerstones, positives of percussion, or tested cobbles affected by fractures or with very few flaking scars (Table 2). The main raw material is local Jurassic limestone (57.6%), followed by quartzite. Cobbles without marks, which were probably collected for a single use only, are mainly composed of local limestone (69%). This raw material is exclusively present in slabs with percussion marks which suggest their use as anvils. Hammerstones and retouchers are of quartzite or quartz (58%) and of local limestone (38%). Flint was not used for this purpose, and



Fig. 6. Cut-marks on tibia fragment. *Equus chosaricus*, CB3.

**Table 1**

Lithic industry observable in the three main levels of Cuesta de la Bajada (L = limestone; Q = Quartzite; Qz = Quartz; F = Flint; SL = Silicified Limestone).

LEVELS Raw materials		LEVEL CB1					LEVEL CB2					LEVEL CB3				
		L	Q	Qz	F	SL	L	Q	Qz	F	SL	L	Q	Qz	F	SL
USED PEBBLES	Hammerstones and anvils	6	3	1	0	2	8	15	3	0	2	18	15	2	0	2
	Fractured pebbles	8	3	2	0	2	13	2	1	0	12	20	2	0	0	7
	Subtotal (% by level)	14 4.3	6 1.8	3 0.9	0 0	4 1.2	21 2.3	17 1.9	4 0.4	0 0	14 1.5	38 2.1	17 1.0	2 0.1	0 0	9 0.5
	Cores	0	3	0	0	24	17	13	0	3	79	16	19	4	8	90
CORES AND TOOLS SHAPED ON PEBBLES	Chunks	0	0	2	0	18	4	10	6	3	63	4	8	3	5	86
	Knapped pebbles	0	0	0	0	0	3	0	0	0	1	2	0	0	0	1
	Large pebble tools	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Small pebble tools	1	0	0	0	1	2	0	0	0	5	2	1	0	0	9
	Subtotal (% by level)	1 0.3	3 0.9	2 0.6	0 0	43 13.3	26 2.8	23 2.5	6 0.7	6 0.6	149 16.4	24 1.3	28 1.6	7 0.4	13 0.7	186 10.4
FLAKES AND KNAPPED PRODUCTS	Flakes and flake fragments	5	19	11	6	84	21	96	28	13	230	43	116	28	28	474
	Retouched flakes	1	8	0	8	45	2	29	3	10	94	3	22	1	14	156
	Waste (small knapped flakes)	0	7	2	6	32	1	14	3	5	68	1	73	9	33	394
	Resharpening flakes	0	0	0	0	14	0	3	0	1	24	0	4	0	4	54
	Subtotal (% by level)	6 1.8	34 10.5	13 4.0	20 6.2	175 54.0	24 2.6	142 15.6	34 3.7	29 3.2	416 45.7	47 2.6	215 12.1	38 2.1	79 4.4	1078 60.5
Subtotal by levels and raw materials		21	43	18	20	222	71	182	44	35	579	109	260	47	92	1273
Total by levels		324					911					1781				
Excavated area		73 m <sup>2</sup>					62 m <sup>2</sup>					46 m <sup>2</sup>				

silicified limestone was used only occasionally. It is also interesting to observe transfers of use exploitation/percussion in several cores, with clear marks of having also been used as hammerstones.

Clasts that were most intensively used in percussion activities are easily identified thanks to macroscopic percussion marks (Fig. 7a) and detachments. The distribution of size is clearly discontinuous (Fig. 7b) with 12 values grouped between 100 and 230 g, 5 between 350 and 440 g and another 5 of very small size – weights between 10 and 36 g – which may have been used exclusively as retouchers. Most of these clasts (80%) were quartzite cobbles imported from the Guadalaviar river basin or the Gea glacis (Fig. 4).

### 2.3.3. Production phase

**2.3.3.1. Flakes.** Flakes account for 78% of the production phase (sub-phases 1 to 6, Table 2). A total of 24% are completely cortical or maintain cortex on more than half of their surface; most do not retain their cortex (41%) or only keep it in less than half of their surface (11%). The 23% of the flakes have cortical or debitage back, consistent with exploitation models equivalent to the Quina and Levallois concept recognised in the cores. Only 3 flakes have a double bulbar face, whose counterpoint is the existence of some Kombewa cores.

The small size of the flakes, consistent with the size of the cores, is a fundamental feature of the industry of Cuesta de la Bajada. The

technical measurements undertaken on the complete non-fractured samples give average values of 23.7 × 21.9 × 7.8 mm (LxWxT). These values are very close to the median values (Table 3), with maximum values which rarely exceed 60 mm for both length and width. This small size almost coincides with the technical measurements undertaken on the well-preserved negatives of the cores (Table 4; Fig. 8).

**2.3.3.2. Cores.** We have taken into account the organisation of debitage, the hierarchical structure of these surfaces, raw materials, types of blanks, sizes and intensity of exploitation.

In quartz and quartzite, more or less flat cobbles with rounded sections were usually employed. However, in silicified limestone and flint, the original matrix was usually angular cobbles, with a clear trend towards the adaptation of the exploitation to the natural faces. The reaction of silicified limestone produces frequent unclassifiable fragments (chunks) to a larger extent than in other rocks (Table 5). The reduced sizes of the cores are as might be expected given the size of these flakes. The largest of these, more than 78 mm in length, are all made of local non-silicified limestone (Table 6; Fig. 9).

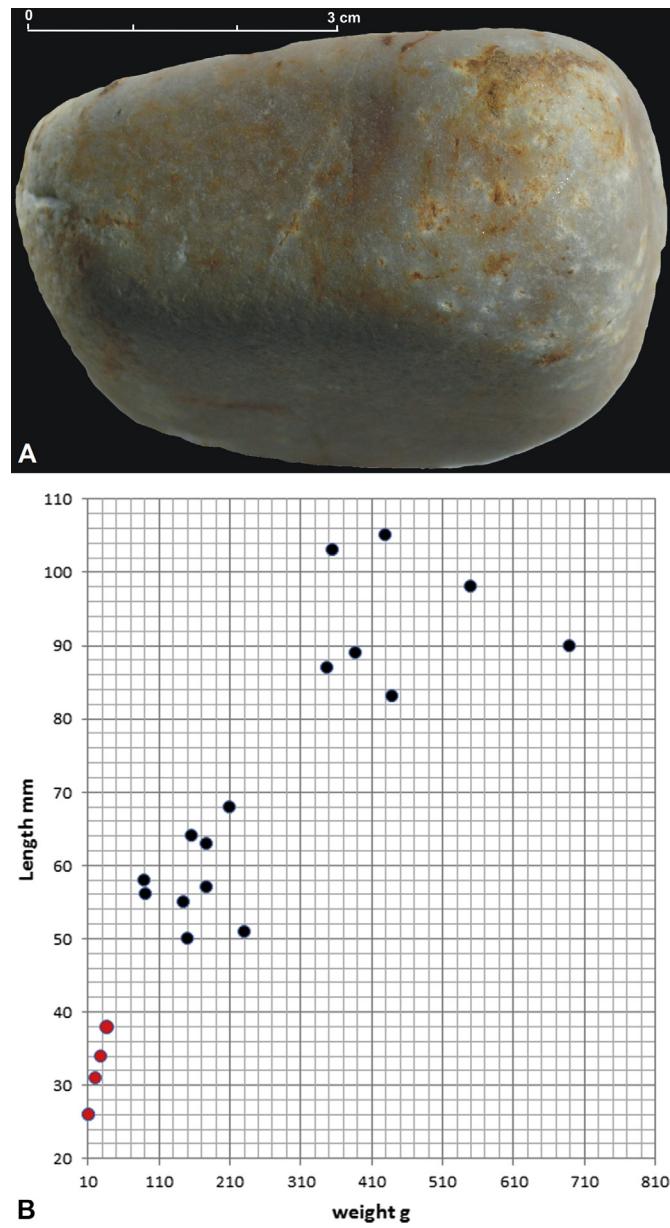
Depending on the predominant exploitation scheme, we have distinguished eight groups of cores in CB3 (Fig. 10), two of which are specific to the site (Scheme A and B). Local non-silicified limestone cobbles are the most common blank and raw material (10)

**Table 2**  
Chaîne opératoire phases identified in CB3 Level.

	Natural elements	Tools	Total
<b>0. Acquisition phase</b>			
0.1 Pebbles, hammerstones	9	22	31
0.2 Tested pebbles	0	29	29
0.3 Positives of percussion	6	0	6
<i>Subtotal acquisition phase</i>	15	51	66
<b>1. First reduction phase</b>			
1.1 Highly cortical flakes (>90% cortex)	52	22	74
1.2 Cortical flakes (50–90% cortex)	50	25	75
1.3 Cortical flake fragments (Ff)	56	3	59
<b>2. Full reduction phase (ordinary products)</b>			
2.1 Decortical flakes and Ff (<10% cortex)	318	41	359
2.2 Partially cortical flakes and Ff (10–50% cortex)	85	12	97
2.3 Janus flakes and Ff	1	2	3
<b>3. Full reduction phase (backed products)</b>			
3.1 Flakes and Ff with débitage back	45	30	75
3.2 Flakes and Ff with cortical back	70	46	116
3.3 Pseudo-Levallois points	7	6	13
<b>4. Levallois products</b>			
4.1 Levallois flakes	5	2	7
4.2 Levallois points	0	0	0
<b>5. Cores</b>			
5.1 Cores on pebble	80	15	95
5.2 Cores on flake	9	1	10
5.3 Cores on undetermined blank	28	4	32
5.4 Chunks	106	0	106
<b>6. Ramification products</b>			
6.1 Flakes of resharpening tools	62	7	69
<i>Subtotal production</i>	974	216	1190
<b>7. Façonnage and retouched items on pebble or slab</b>			
7.1 Bifaces + cleavers + picks	0	0	0
7.2 Knapped pebbles	0	3	3
7.3 Small tools on pebble or slab	0	12	12
<i>Subtotal façonnage</i>	0	15	15
<b>8. Waste (&lt;10 mm)</b>			
8.1 Small knapped flakes > 3 mm with cortex (>10%)	98	0	98
8.2 Small non-cortical knapped flakes > 3 mm (<10%)	412	0	412
<i>Subtotal waste</i>	510	0	510
<b>Total</b>	<b>1499</b>	<b>282</b>	<b>1781</b>

among the 22 unidirectional cores (Fig. 10.3). On two occasions, two independent surfaces were exploited, and there is also a sample with independent removals on three planes. The rest are occasional cores (4) with some isolated extraction or exhausted cores in which only a final extraction can be identified (5). The 22 bidirectional cores are opportunistic, which tend to adapt to the most easily exploitable planes of silicified limestone cobbles of a small size (Fig. 10.4). A number of them are exhausted pieces, with final bidirectional extractions on one surface (6) or two (3), partly bifacial. The multidirectional cores (Fig. 10.5), with successive extractions in multiple directions and on three or more surfaces are infrequent in CB3, probably due to the small size of the silicified limestone cobbles available.

Most of 20 bifacial cores identified were silicified limestone (Table 7). Thirteen of bifacial cores (2 of which are on flakes) show



**Fig. 7.** A) Rounded pebble of quartzite with traces of use as a hammerstone (CB3/2147). B) Weight histogram (g) of hammerstones, CB3 level.

extractions on one side, with debitage that only occasionally corresponds to a clactonian scheme (SSDA; Forestier, 1993). In two cases, bifacial exploitation was performed on two independent edges, and in six samples bifacial exploitation covers nearly the whole outline. Some of these show a clear centripetal tendency whether on one or both of the main surfaces (Fig. 10.6).

Among the cores with organised debitage were those showing centripetal schemes (Boëda, 1993; Mourre, 2003). These were exploited in planes oblique to the main symmetry plane from peripheral percussion surfaces and taking advantage of natural faces (2), or with preparation of peripheral convexities in many cases (11). Other cores show preferential surfaces of a centripetal character, although they are not exclusively associated with extractions in other surfaces (3). Most of the blanks in this group of cores are silicified limestone cobbles (Table 7). It is also worth noting four levallois cores of flakes (Boëda, 1994; Inizan et al., 1999), two with preferential removal (Fig. 10.8) and another two recurrent cores,

**Table 3**  
CB3 Level. Size of flakes (mm).

	Complete flakes			Flake fragments		
	Length	Width	Thickness	Length	Width	Thickness
N	431	436	464	226	226	226
Intervals X/x	61/9	59/7	26/2			
Mean	23.7	21.9	7.8	19.2	18.1	6.8
Median	22	21	7			

one linear and one centripetal (Fig. 10.7). The series contains 38 flakes with exploitation schemes on the dorsal surface originating in centripetal, discoidal or levallois exploitation surfaces.

Apart from the presence of seven flakes exploited as cores according to different patterns there are three middle-size flakes, two of silicified limestone and one of quartzite, with considerable thicknesses (15/17 mm) and showing wide single removal on the ventral face. These are wholly consistent with the Kombewa concept (Newcomer and Hivernel-Guerre, 1974). Among the flakes there are three Kombewa samples.

Cores of schemes A and B represent a specific component of the exploitation system adapted to the raw material in CB (Table 7). Scheme A – 14 samples - comprises cores characterised by a wide extraction which completely covers the main extraction surface (Fig. 10.1). This extraction takes place from an orthogonal percussion platform, either faceted, flat or cortical. Some cases in CB -although not in CB3- show remains of more than one wide negative on the main surface (variant 1), or two independent extraction surfaces, adjacent or not (variant 2, 3 cases in CB3). Considering the small size of the blanks we cannot dismiss occasionally bipolar knapping.

Scheme B (25 samples) is a development of Scheme A. It comprises cores showing successive unidirectional removals, peripheral and oblique to an initial surface and parallel to the equatorial plane (Fig. 10.2, 10.9, 10.10). This surface is created by means of a wide and complete extraction, which is adapted to the contour of the core (as in Scheme A), and has sometimes been re-exploited. We also include in this group pieces with orthogonal extractions peripheral to a cortical plane (variant 1, 7 cases), pieces on flakes with orthogonal removals peripheral to the plane formed for the bulbar surface (variant 2, 2 cases), and cores with remains of two or more total negatives on the initial surface that were created prior to or after the peripheral exploitation (variant 3, 4 cases). Again, the preferred raw material for this group, was silicified limestone (Table 7).

Both schemes A and B are consistent with a basic Quina concept (Bourguignon, 1998). The main objective of this approach is the production of thick flakes asymmetric in section, with debitage or cortical backs, using methods that are well-adapted to the small size of the raw materials at the site. The production of this type of flake reaches a relevant percentage. 11% and 17% of all flakes in CB3 are debitage or cortical backed flakes, but of most significance is their rate of transformation into tools by retouching, which reaches 40% in both cases, whereas ordinary products reach 12% at CB3.

The intense use of natural surfaces as percussion platforms (Table 8) is consistent with the high percentage of cortical butts

observed in the flakes (42%). And there is a low representation abundance of preparation for percussion platforms, due owing to the small size of the exploited blanks.

### 2.3.4. Consumption and discard phase

The industry of level CB3, like that of the whole site, is characterised foremost by the absence of elements configured by *façonnage* (Table 2), and by the abundance and variety of retouched tools, with the percentage of transformation of flakes standing at 18.6%. Small cobbles of sizes comparable to those of flakes, as well as a 15% of cores were also retouched (Tables 2 and 9). Retouching seems to have been made exclusively by hammerstones, which, on occasions were of a small size (Fig. 7b). A minimum of 69 characteristic resharpening flakes with wide flat butts have been identified, which, bear in their proximal area the remains of retouching of the initial flake (Fig. 11.1–3) and are occasionally themselves retouched (Fig. 11.3). In some cases, they can be assimilated into types I–III and type IV (Bourguignon, 1997), with genuine notches on the flake-support and a transformative contact of the edge (Faivre, 2010).

The selection of blanks is also reflected in the choice of the biggest size flakes, as well as in the preference for flakes with backs, both for retouching purposes (28%) and for tool use (13%). Specifically, average lengths and widths of retouched flakes are nearly 1 cm larger than non retouched flakes, and their thicknesses are several mm greater (Table 9). The variety of retouched tools (Fig. 11) includes scrapers, denticulates, notches, *becs*, awls and tools of the Upper Paleolithic group (*sensu* Bordes, 1961). Additionally, integrated in the knives-with-back group, there are flakes with wide removals or small retouches and flakes with edges opposed to backs (cortical, retouched or debitage backs).

Scrapers (72 samples) are the major typological category (Fig. 11.5–7). Six of these were elaborated from small pebbles, five from exhausted cores and four on resharpening flakes of other scrapers or denticulates. In many cases they were elaborated on flakes of asymmetrical section, which show scraper fronts opposed to cortical or debitage backs (24). There are also a significant number of convergent scrapers (12), some of them very pointed. The rest (36) are simple scrapers.

The 59 Denticulates (Fig. 11.8–12) were elaborated from small cobbles (4), exhausted cores (9) and a predominance of flakes (46). In terms of raw materials (Table 10), the only difference from the scrapers is the lack of quartzite and in quartz. The sizes between scrapers and denticulates are similar (Table 11). In most denticulates only one side was modified by simple retouching but five pieces show double and eight convergent retouching, some of which occur on natural slabs and are of a very small size (Figs. 11 and 4). A third of denticulates on flake show thick backs.

It is worth noting the presence of four awls (Fig. 11.13, 11.14), a *tranchet* with a natural straight edge between retouched sides, and an end-scraper. Other less elaborated tools include 6 *becs* (Fig. 11.15), 30 notches, 16 flakes with limited retouching and 9 with wide removals, which show a certain resemblance with knapped pebbles. In all these subgroups there are samples of asymmetric flakes, with backs opposed to the notche.

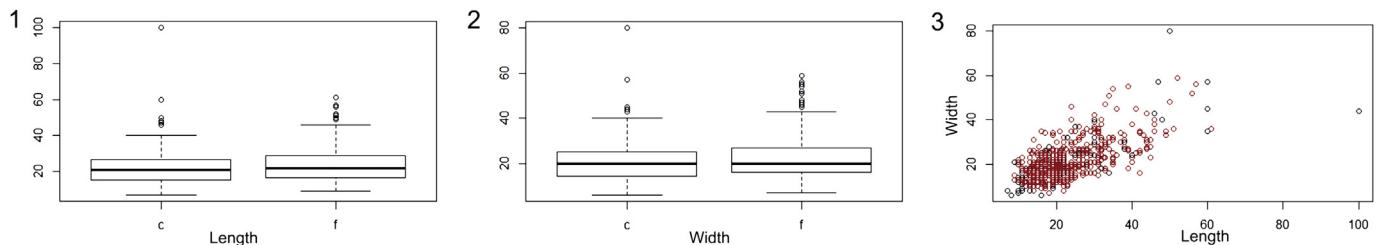
## 3. Discussion

### 3.1. The site

The archaeo-stratigraphic levels described at Cuesta de la Bajada (Fig. 5) correspond to low-energy sedimentary environments. These facies and their plan/cross-sectional morphologies support the existence of a closed-geometry depression or small basin (pond) formed by local deformation of the subsiding alluvial substratum of the Alfambra River. This feature was more or less

**Table 4**  
CB3 Level. Size (mm) of complete negative scars observed in cores.

	Length	Width
N	113	108
Intervals X/x	60/7	59/6
Mean	23.1	21.7
Median	22	20



**Fig. 8.** Relationship between flake size and scar size on cores. (1, 2) Median values and sample distribution of technical measurements of flakes -length and width- (f) and well-preserved negative cores (c). (3) Plot of technical measurements of flakes -length and width-(red dots) and well-preserved negative cores (black dots). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

**Table 5**  
CB3 Level. Raw material of cores and chunks.

Rocks	Cores	Chunks
Silicified limestone	90–65.6%	86–81.2%
Limestone	16–11.7%	4–3.8%
Quartzite	19–13.9%	8–7.5%
Quartz	4–2.9%	3–2.8%
Flint	8–5.8%	5–4.7%
Total	137	106

**Table 6**  
CB3 Level. Size (mm) of cores.

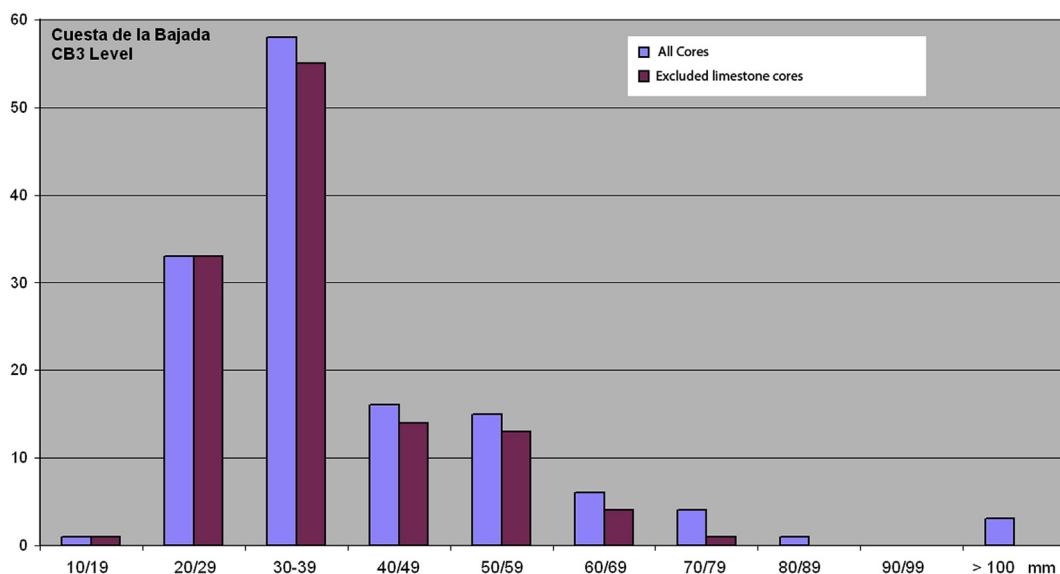
	All cores			Excluded limestone cores		
	Length	Width	Thickness	Length	Width	Thickness
N	137	137	137	121	121	121
Intervals X/x	176/18	117/12	77/7	78/18	62/12	53/7
Mean	40.4	30.3	20.8	36.6	27.1	18.7
Median	35	28	18	33	26	16

elongated, with a maximum length of 40 m, a N90° orientation and an aerial coverage of 350 m<sup>2</sup> of preserved extension. The depression was filled with materials produced by overland flow from the surrounding alluvial surfaces, but was not affected by flooding of nearby channels.

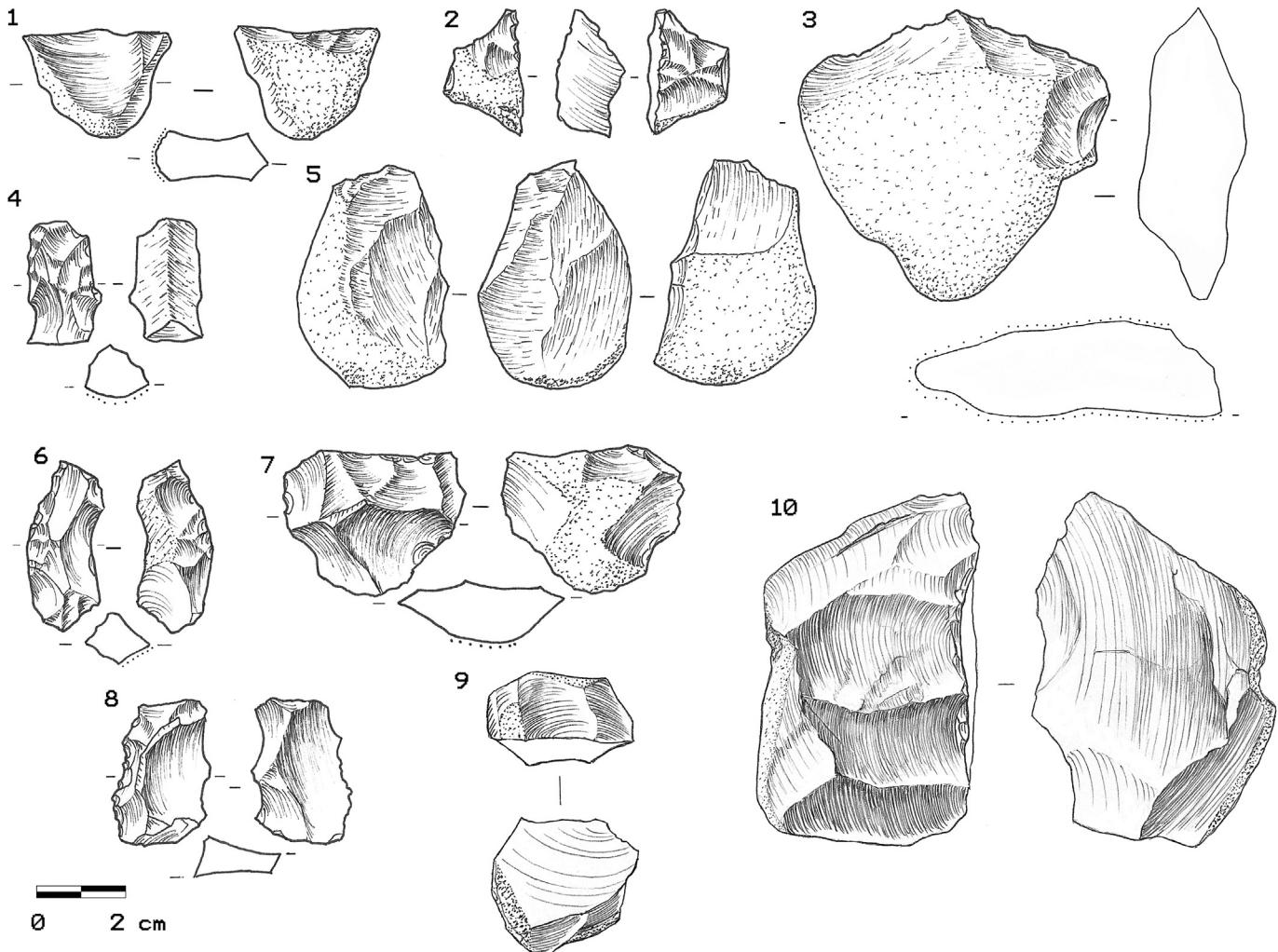
With regard to the paleoenvironmental significance of the macromammals, there is shows a predominance of ecotonal species that would have lived on the edge of forested and prairie landscapes is evident, as typified by the presence of *Capra* sp. and *R. rupicapra*. All of the micromammal species indicate the development of some vegetation cover and most are indicative of open countryside settings. This type of micromammals assemblage, in which *M. cf. duodecimcostatus* and *M. brevirostris* are the most abundant taxa, is suggestive of a temperate climate with Mediterranean influences.

Cuesta de la Bajada site was formed around a pond not far from a river and contains remains of large macrofauna other than equids and cervids. The representation of other taxa by a few remains per individual supports the idea that the site includes naturally-deposited carcasses. By contrast, the equid and cervid carcasses are much better represented: one could theoretically argue that they were accumulated by large carnivores (felids) and were confrontationally scavenged by hominids. However, the consideration of carcass size (equids) and possible predator size (large felids) and the age profiles of the equids and cervids do not support carnivore-first models.

The formation process identified and the presence of a considerable amount of small debris (Tables 1 and 2; chips smaller than 3 mm not included), such as numerous bone fragments, corroborate that the archaeological assemblage is essentially preserved in an autochthonous position. The preservation of all phases of the *chaîne opératoire*, confirm that knapping was performed *in situ*. The



**Fig. 9.** Size distribution of cores (mm).



**Fig. 10.** Cores. 1: Scheme A; 2, 9 and 10: Scheme B; 3: Unidirectional; 4: Bidirectional; 5: Multidirectional; 6: Bifacial with centripetal organization; 7 and 8: Levvalois recurrent centripetal and with preferential removal.

tools and flakes originating from reshaping, together with the cut marks observed in bones, constitute clear evidence that the former were used on-site prior to being discarded. Blocks displaying traces of impact marks, especially neogene limestone blocks, can be found in coincidence with fractured bones. Some of the percussion activities that left traces on these blanks would not be related to knapping, but to the processing of animal remains.

### 3.2. Significance of the Cuesta de la Bajada site for understanding the regional Lower/Middle Paleolithic sequence

The process of lithic production at Cuesta de la Bajada is very different from the functional solutions of the European Acheulean technocomplex, which is characterised by volumetric concepts of bifacial shaping and the production of large support flakes. Instead, Cuesta de la Bajada represents a technology focused on debitage, the application of technical concepts such as ramified production sequences, and the recycling of flakes via the resharpening of tools and exhausted cores. This kind of technology reaches its full development in the Mousterian industries, and can also be found in preceding Middle Pleistocene Southern European core, flake and tool industries (Moncel et al., 2012; Rocca, 2013; Turq et al., 2010; Lumley and Barsky, 2004), as well as in Central Europe at sites such as Bilzingsleben, Vertesszölös or Schöningen that have been

dated to MIS 9/MIS 11 (i.e., similar to Cuesta de la Bajada) (Rocca, 2013; Van Asperen, 2012).

The results obtained using OSL and ESR dating display good internal consistency and good overall agreement between the different methods (Fig. 5). However, the ages obtained using AAR are systematically older than the OSL and ESR chronologies. If we consider the TIMS U-series ages for the Los Baños T4 terrace as being broadly coeval with the Cuesta de la Bajada T4 deposits, the most likely age of the site would be MIS 8 or 9 (243–337 ka) rather than MIS 11 or 12. This interpretation would be consistent with the published ages of ~130–210 ka (i.e., MIS 6–7) for the stratigraphically younger T7 (+20–25 m) terrace preserved at La Rambla.

From a biostratigraphical point of view, the *M<sub>1</sub>* of *A. aff. sapidus* is clearly larger than that of *Arvicola mosbachensis* at the Middle Pleistocene site of Mosbach 2 (Maul et al., 2000) and is also slightly larger than the population of this species at the early Middle Pleistocene site of Cúllar de Baza I (Ruiz Bustos and Michaux, 1976), which has been dated to 476 ± 24 ka using AAR (Ortiz et al., 2000). The morphology and size of *A. aff. sapidus* at CB is similar to that reported at the Áridos 1 site located in the stratigraphic unit of Arganda I, dated by AAR to 332 ± 38 and 379 ± 45 ka (López Martínez, 1980; Panera et al., 2011). The evolved stage and the size of the *M<sub>1</sub>* of *M. brevirostris* from CB also fits well with

**Table 7**

Cores by débitage method at CB3 level.

Conceptual scheme	Raw materials (SL= Silicified Limestone; L = limestone; Q = Quartzite; Qz = Quartz; F = Flint)				
	SL	L	Q	Qz	F
Scheme A	12	2	0	0	0
Scheme B	15	3	3	2	2
Unidirectional	8	10	2	0	2
Bidirectional	18	0	2	2	0
Multidirectional	2	0	3	0	0
Bifacial	13	1	4	1	1
Discoidal	11	1	3	0	1
Levallois	3	0	0	0	1
Exhausted and undetermined	5	0	0	0	1
Total (137)	89	17	18	5	8

populations of the same species from the sites of Cúllar de Baza I, Áridos 1 and Valdocarros II (Sesé et al., 2011). The latter site has two AAR ages of  $262 \pm 7$  and  $254 \pm 47$  ka (Panera et al., 2011). The tooth sizes of *C. (Allocricetus) bursae* from Cuesta de la Bajada are generally larger than for the population of this species found at Cúllar de Baza I, and similar to those preserved at Áridos 1.

These chronologies allow us to place Cuesta de la Bajada within a firm temporal framework and to discuss its significance in relation to other Middle Palaeolithic sites of the Iberian Peninsula that share comparable chronologies – some of which have been overlooked in previous regional comparisons. Our objective is to emphasise once again the coexistence of two radically different technocomplexes in the Iberian Peninsula during the second part of the Middle Pleistocene – the Acheulean and the EAMP – and to discuss the relationships between these technocomplexes as either being part of a transitional, replacement process, or as being two autonomous traditions with independent origins.

Middle Pleistocene sites with EAMP industries are known throughout southern Europe and, unlike the Acheulean sites they are found both in caves and in open-air sites (Jaubert, 1999; Delagnes et al., 2007; Richter, 2011). Over the last few years, the number of EAMP sites has increased significantly in the Iberian Peninsula with chronologies similar to that of CB site (i.e., end of MIS 9 or beginning of MIS 8). Together with Cuesta de la Bajada, the most representative open-air Iberian sites for this type of industry are Ambrona (Soria, Spain) and Solana del Zamborino (Granada, Spain). Cave sites with representative EAMP industries include Gran Dolina (Burgos), Bolomor (Valencia), Cueva de las Grajas (Málaga) and possibly Cueva del Ángel (Córdoba).

The lithic industry of the middle stratigraphic unit of Ambrona, dated to  $\sim 350$  ka by combined ESR/U-series of fossil teeth (Falgueires et al., 2006), is characterised mainly by the development of flake tools, scrapers and denticulates (Rubio-Jara, 1996; Santonja and Pérez-González, 2010). Solana del Zamborino, with an estimated age  $\sim 300$  ka based on the association of micro-mammals, is characterised by the development of debitage and flake tools, in association with bifaces-tool support (Jiménez-Arenas et al., 2011).

The industry of the upper part of the Gran Dolina (Atapuerca complex, Burgos) TD10 stratigraphic unit may be accepted as EAMP (Ollé et al., 2013). ESR/U-series ages obtained indicate that the section was deposited sometime during late MIS 11, MIS 10 or early MIS 9 (Falgueires et al., 1999). However, TL dating on polymineral fine-grain fractions of the lower section at TD 10.2 has produced a younger age of  $244 \pm 26$  ka ( $n = 3$ ); i.e., within MIS 8 (Berger et al., 2008). The lower Phases I and II at Bolomor cave (Valencia) have been dated by AAR to  $525 \pm 125$  ka and by TL to  $233 \pm 35$  ka and  $225 \pm 34$  ka, respectively. The industry of Bolomor is centred on the ramified production of small flake tools and exhausted cores, and shows a variability which indicates a clear economy of raw

materials and of debitage (Fernández Peris et al., 2008). The cave of Las Grajas (Málaga), still poorly known, comprises a sequence that has been chronologically assigned to MIS 8 according to the evolutionary stage of the micromammal (Sesé and Sevilla, 1996). The industrial assemblage of Las Grajas has been considered as Mousterian of non-Levallois facies (Benito del Rey, 1982), and it also includes characteristic ramification processes.

Cueva del Ángel, with its characteristic flake and bifaces-support Mousterian industry (Barroso Ruiz et al., 2011), offers close parallels with Solana and even with Ambrona, despite lacking Levallois debitage and having a more recent preliminary U-series age of  $\sim 120$  ka. The biochronology is apparently consistent, since the associated fauna at Cueva del Ángel may correspond to the latest part of the Middle Pleistocene.

Based on the numerical chronologies of Ambrona, Gran Dolina TD10, and Cuesta de la Bajada, the Middle Paleolithic industry begins at least around MIS 9. Similarly, the chronologies developed for Valdocarros, Torralba, Arriaga and the terraces around +20 m of the Duero basin show that characteristic Acheulean industries can be as young as MIS 6. In the south of France the situation seems to be very similar (Moncel et al., 2005; Mourre and Colonge, 2007; Bourguignon et al., 2008; Hernández et al., 2012).

#### 4. Conclusions

According to the new numerical chronologies obtained in this study, Cuesta de la Bajada archaeological site was probably formed sometime during the MIS 8 or MIS 9 (i.e., 243–337 ka; Lisiecki and Raymo, 2005). The formation process of level CB3 indicates that the archaeological assemblage is essentially preserved in an autochthonous position. This site was formed around a pond not far from a river and contains remains of large macrofauna other than equids and cervids; these were likely deposited naturally because the setting would have acted as a magnet for animals. The equid and cervid carcasses are highly represented. The high abundance of prime-adults in both taxa support a hypothesis of hominids hunting, and hunting selectively.

**Table 8**

Butts by raw material of no retouched flakes at CB3 level (C = cortical; Fl = flat; D = dihedral; Fc = faceted; P = punctiform; R/F = remove or fractured).

Raw material	C	Fl	D	Fc	P	R/F	Total
Silicified Limestone	182	207	26	3	3	16	437
Limestone	15	6	1	0	1	0	23
Flint	5	19	3	1	0	2	30
Quartzite	26	41	5	1	1	3	77
Quartz	4	5	0	0	0	0	9
Total	232	278	35	5	5	21	576
%	40%	48%	5%	1%	1%	4%	
Identified butts (%)	42%	50%	6%	1%	1%	—	555

**Table 9**

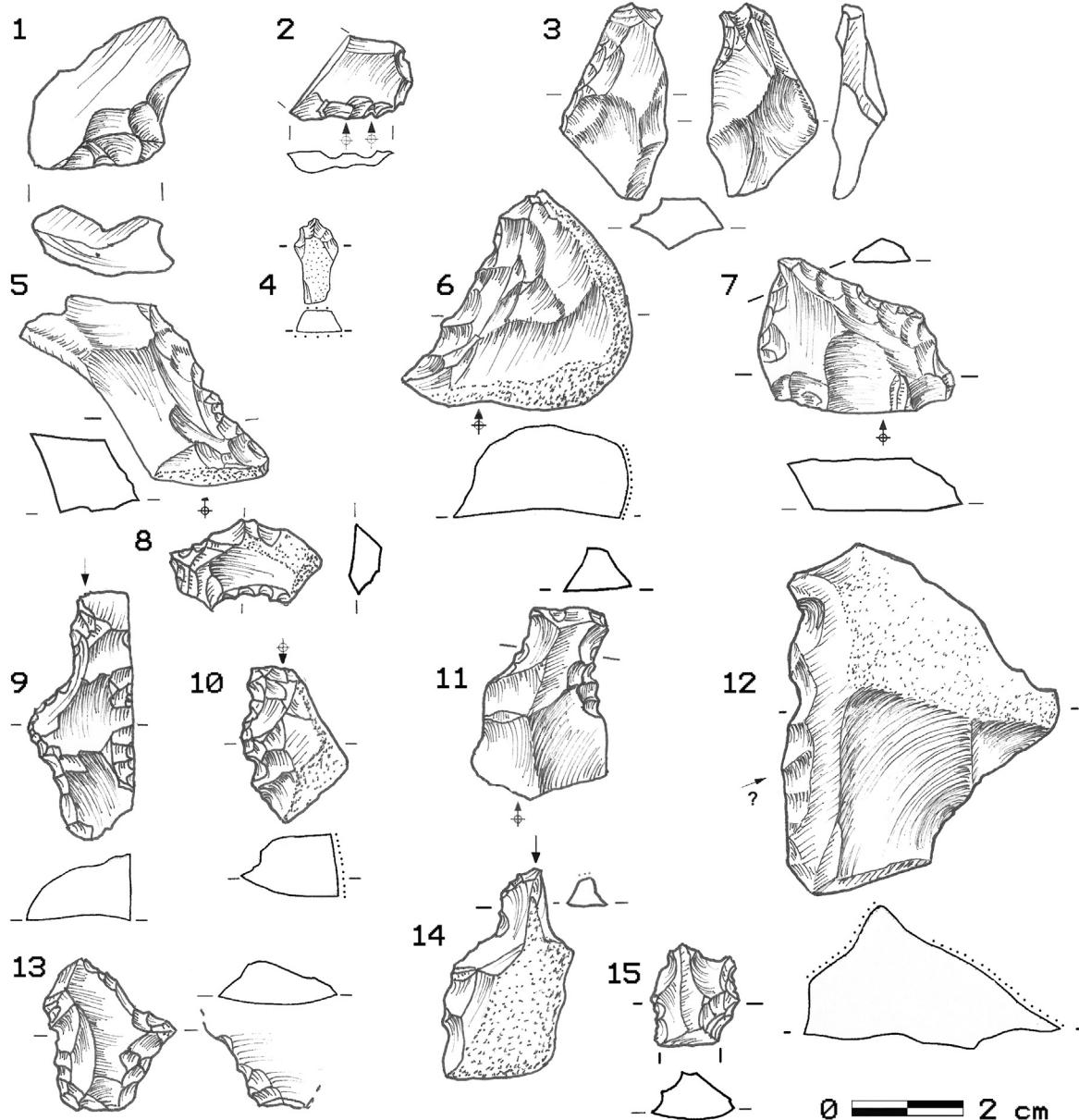
Size (mm) of retouched tools on flake, pebble or slab at CB3 Level.

	Tools on flake (complete)			Retouched pebbles/slabs		
	Length	Width	Thickness	Length	Width	Thickness
N	110	100	183	11	12	12
X/x	75/12	58/10	25/4	42/15.5	28/8	18/4
Mean	30.8	28.29	10.5	30.0	20.9	11.4
Median	34	28	11	29	21	11/12

As indicated above, lithic production at Cuesta de la Bajada represents a technology focused on debitage, the application of technical concepts such as ramified production sequences, and the recycling of flakes via the resharpening of tools and exhausted cores. This kind of technology reaches its full development in the Mousterian industries, and can also be found in preceding Middle Pleistocene Southern European core, flake and tool industries

(Lumley and Barsky, 2004; Delagnes et al., 2007; Turq et al., 2010; Moncel et al., 2012), as well as in Central Europe at sites such as Bilzingsleben, Vertesszöllös or Schöningen that have been dated to MIS 9/MIS 11 (i.e., like Cuesta de la Bajada) (Van Asperen, 2012; Rocca, 2013).

In the Iberian Peninsula there is a clear coexistence of assemblages with Acheulean and Middle Paleolithic industries during the last third of the Middle Pleistocene. Based on the numerical chronologies of Ambrona, Gran Dolina TD10, and Cuesta de la Bajada, the Middle Paleolithic technocomplex begins ca. MIS 9. Similarly, the chronologies developed for Valdocras II, Torralba, Arriaga IIa and the terraces around +20 m of the Duero basin show that characteristic Acheulean industries can be as young as MIS 6 (Santonja and Pérez-González, 2010). In southern France the situation seems to be very similar (Moncel et al., 2005; Bourguignon et al., 2008; Mourre and Colonge, 2007; Hernández et al., 2012). In Northern France there is a lower frequency of Acheulean



**Fig. 11.** 1–3: Flakes from resharpening, No. 3 retouched. 4: Denticulate over a little slab. 5–7: Scrapers. 8–12: Denticulates. 13–14: Awls. 15: *Bec*.

**Table 10**

Tools on flake by raw material at CB3 (%).

Types of retouched pieces according to F. Bordes (1961)	Silicified limestone	Limestone	Flint	Quartzite	Quartz	Total (N)
Scrapers	80.5	1.4	7.0	11.1	0	61
Denticulates	81.4	3.4	15.2	0	0	46
<i>Tranchets</i> , End-scrapers and awls	83.3	0	16.7	0	0	6
Becs	100	0	0	0	0	6
Notches	86.7	3.3	3.3	3.3	3.3	27
Retouched flakes	87.5	0	0	12.5	0	16
Backed knives	57.7	3.8	3.8	34.6	0	26
Wide knapping flakes	66.7	0	0	33.3	0	8

technocomplex. At the same time, however, sites with cores-flakes industries and tools, and with chronologies spanning either the pre- or post-MIS 9 period, are documented in Central and Eastern Europe, where the Acheulean has never been found (Doronichev and Golovanova, 2010; Rocca, 2013).

A discussion on the changes that occurred in European societies of the later Middle Pleistocene should take into consideration aspects relating to behaviour (Villa, 2006, 2009; Chazan, 2009). However, here we exclusively focus our attention on lithic technology, with a particular emphasis on the theoretical evolutionary relationship between the two technological entities known to have occurred in Europe during the Middle Pleistocene.

We should not ignore the dichotomy observed between the southern regions and the rest of the continent (Monnier, 2006; Moncel et al., 2012; Hopkinson, 2007). Sequences such as that recognised in the Somme basin, in northern France, more than 20 years ago (Tuffreau, 1992; Moncel et al., 2005) seemed to justify the hypothesis of a transformation between the Acheulean and the Mousterian that occurred through different intermediate facies. However, the coexistence of Acheulean and Mousterian industries lasting around 150 ky that have been documented so far in the Iberian Peninsula and Aquitaine shows a different situation. If we examine the general scenario from the south of Europe, the intrusive character of the Acheulean technocomplex in the ancient European Paleolithic seems evident, as already suggested by Otte (2001). In this scenario, the Acheulean would have reached Europe through Gibraltar (Santonja and Villa, 2006; Santonja and Pérez-González, 2010; Sharon, 2011) at a later date than its appearance in Africa, Middle East, India and probably S.E. Asia (Bar-Yosef and Belmaker, 2011). The geographic distribution of the European Acheulean, particularly its absence in the Russian plain and the centre of the continent, practically eliminates the possibility of an inland connection, and limits the origin of this technocomplex to either Gibraltar or to a European re-invention, as has been recently proposed (Nicoud, 2013). However this latter hypothesis is based on an incomplete analysis of the Acheulean phenomenon in southern Europe, which is the only region of the continent that would have been affected by such a reinvention. It would also imply the convergence of processes separated by more than a million years and prevailing under totally different circumstances (i.e.,

involving different hominin species and paleoenvironmental conditions).

The situation we observe across southern Europe seems to correspond better to an evolutionary process of European populations with core and flake industries that entered in contact with human groups of African origin associated with the Acheulean technology. The timing of this event corresponds to sometime during the Middle Pleistocene, certainly during MIS 12, but it could also have started earlier at MIS 16 according to some authors (Moncel, 2010, 2013). Cultural contacts and exchanges may have produced multiple and heterogeneous responses in the late Middle Pleistocene European lithic industry and would have taken place in a context characterised by very low population densities, and where large areas remained almost uninhabited during the coldest periods, even in the south of Europe (Dennell et al., 2011; MacDonald et al., 2012). The non-linear evolutionary scenario we propose has a good counterpoint in recent anthropological models, which recognise a variety of lineages in the European Middle Pleistocene (Tattersall, 2011) and highlight the marked autonomy of the first human populations of Eurasia in relation to those of the African continent (Dennell et al., 2010) and the African roots of *Homo heidelbergensis* (Rightmire, 2008; Hublin, 2009; Mounier et al., 2009), connections that in the past have been explicitly related to the expansion of the Acheulean techno-complex (Hublin, 2009).

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**Table 11**

Main size (mm) of tools on flake at CB3.

Types according Bordes 1961 (N)	Intervals X/x	Mean	Median
Scrapers (61)	49/16	31.0	30
Denticulates (46)	63/16	31.2	30
<i>Tranchets</i> , End-scrapers and awls (6)	39/16	29.3	29/30
Becs (6)	37/16	29.0	26
Notches (27)	45/16	28.3	28
Retouched flakes (16)	75/13	30.9	27
Backed knives (26)	56/21	35.3	36/34
Wide knapping flakes (8)	72/26	37.1	34

All the archaeological and paleontological materials obtained in the excavations are deposited in the Museum of Teruel (Spain) and they are free access to all researchers.

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