The Acheulian of Western Europe

Manuel Santonja and Paola Villa

Abstract

In the current state of knowledge, the European distribution of Acheulian industries that include handaxes and cleavers appears to be centered in southwestern Europe; their maximum northward expansion reaches England and Germany. North of latitude 52° and east of Germany and Italy, handaxe industries are conspicuously absent, occurring only sporadically in southeastern Europe. Handaxe industries are again well documented in western Asia, from Georgia to Israel and the Arabian Peninsula, clearly indicating an East African origin. The gap between eastern and western Eurasia and the high density of finds in the Iberian Peninsula suggests that the Acheulian in southwestern Europe may derive from the Maghreb, notwithstanding the lack of direct evidence for the crossing of the Straits of Gibraltar. In the Spanish Meseta the geological formations containing Acheulian industries are dated to the time range of OIS 11 to 6. The chronological gap between the earlier human occupation sites at Gran Dolina and in the Orce region and the Spanish Acheulian (an interval of about 300–400,000 years) would seem to reflect an earlier settlement in warm-temperate Europe that did not take a strong hold.

The distribution of cleavers coincides only partly with that of Acheulian handaxes. Cleavers are most abundant in regions in which the raw material occurs in the form of large quartzite cobbles that do not need extensive decortication and shaping prior to the removal of large flakes, as in the Spanish Meseta and the Garonne and Tarn valleys of southwestern France. Elsewhere (northern France, England, Italy), cleavers also occur in different raw materials (flint or limestone) but are not common.

In Spain, the transition from Acheulian industries to assemblages characterized by the Levallois method without large cutting tools may be as old as 300 ka, based on the age of stratigraphic units TD 10 and 11 at Gran Dolina. However, the evidence from open-air sites suggests a possible coexistence of industries traditionally called Upper Acheulian and others included in the Mousterian complex up to the end of the Middle Pleistocene. In northern France and adjacent countries (Belgium, the Netherlands), assemblages containing rare bifaces and Levallois debitage occur during OIS 8, broadly contemporaneous with assemblages containing bifaces and non-Levallois debitage. The Levallois method is well documented from OIS 7 onward.

Introduction

The traditional European image of the Lower Paleolithic, first formed in the second half of the nineteenth century and based essentially on the lithic industries of England and northern France, was superseded when African archaeology revealed the true spatial and temporal dimensions of the first stages of humanity. Today, it seems evident that basic questions such as the chronology, sites, paleoenvironment and lithic technology need to be addressed from a global perspective.

East Africa is the center of origin of the first industries and it was in East Africa that the Acheulian Technocomplex emerged at about 1.65 ma (Roche et al., 2003). Europe occupies a marginal geographic position, distant in time and space from the technocomplex's origins (Villa, 2001), since there is no record of human presence in western Europe before the end of the Lower Pleistocene, except for its southernmost regions, Orce and Atapuerca in Spain and perhaps Ceprano in Italy. After a void of several hundred millennia, African-style Acheulian tools appeared in Europe, although only in western regions, from the Iberian and Italian peninsulas to England and central Germany.

In this paper we use a systematic approach to the chronology of the Acheulian assemblages in southwestern Europe, discussing the nature of sites from a geoarchaeological point of view and highlighting morphological and technological elements that are proper to the African-style Acheulian, such as large cutting tools on flakes, particularly cleavers.

Spain

The earliest sites (Figure 1, Table 1)

In the 1970s and 1980s, some European sites were thought to be as early as the Late Pliocene (but see Villa, 1983: 12–14). In the early 1990s, after a systematic revision of the available evidence, Roebroeks and Kolfschoten (1994; 1995) stated that the existence in Europe of human groups before the Middle Pleistocene was not demonstrated. However, the subsequent discovery of several Spanish sites, Fuentenueva 3, Barranco León (both in the Guadix-Baza basin near the city of Orce, southern Spain), Gran Dolina and Sima del Elefante (both in the karstic system of Sierra de Atapuerca near the city of Burgos, northern Spain), was to change this viewpoint, providing firm evidence of human occupation in southern Europe during the Lower Pleistocene.

Fuentenueva 3 and Barranco León (Orce, Granada)

The Tertiary depressions of Granada Province, infilled with Plio-Pleistocene fluvial and lacustrine deposits, contain several exceptional paleontological and archaeological sites (Turq et al., 1996). Among these, Fuente Nueva 3 (FN3) and Barranco León (BL) have yielded faunal and lithic assemblages. The age proposed for these two sites is based on the evolutionary stage of fauna and on magnetostratigraphic determinations. In both sites, paleomagnetism has been assessed in sedimentary layers some 20 m thick, which exclusively show reversed magnetic polarity. Bearing in mind that the faunal record (Martínez Navarro et al., 2003) corresponds to the Lower Pleistocene, the entire sequence is ascribed to the Matuyama Chron, locating it between the Jaramillo and Olduvai Subchrons (Oms et al., 2000). Faunal associations, and more specifically the presence in both sites

1 Atapuerca	5 Áridos	9 Puente Pino	13 Porzuna	15 Fuentenueva 3 and Barranco León
2 Ambrona and Torralba	6 Transfesa and Orcasitas	10 Sartalejo	14 Solana del Zamborino and Cúllar-Baza I	16 Bolomor
3 La Maya	7 San Isidro	11 Albalá		
4 El Basalito	8 Pinedo	12 El Martinete		

Figure 1: Map of the Iberian Peninsula showing regions, rivers and archaeological sites mentioned in the text.

Table 1: Stone artifacts from Barranco León (BL), Fuentenueva 3 (FN3), Gran Dolina level TD6 (GD) and Sima del Elefante (SE).

Assemblage composition	**BL**	**FN3**	**GD**	**SE**
Cobbles with isolated scars (tested blocks, occasional cores)	3	8	18	
Cores and core fragments	6	11	1	
Flakes and flake fragments >2 cm	124	170	159	25
Flakes and flake fragments <2 cm	146	51		
Flakes with continuous or irregular retouch	16	4	27	
Total	**295**	**244**	**205**	**25**

of *Allophaiomys* cf. *lavocasti* (=*A. burgondiae*), also suggest a provisional age of 1.3/1.2 ma (Agustí and Madurell, 2003).

In the BL site, faunal and lithic assemblages have been observed in a fluvial sand level of varying thickness (20 to 60 cm). The energy of the environment could have displaced archaeological remains, although appreciable amounts of small flakes and debris suggest a good state of preservation. The set of artifacts obtained until the 2002 field season from 114 m^2 includes 295 artifacts (Table 1) of flint (90%), as well as quartz, quartzite and limestone pebbles, all available in the immediate surroundings (Toro et al., 2003b). Though the sample is rather small, some of its technological features point to a certain degree of complexity:

- Discoid cores with centripetal removals invading the entire main exploitation surface.
- Use of flakes as cores and presence of Kombewa flakes.
- Proportions of faceted butts approaching 8%.
- Presence of well-configured side scrapers (a double alternate scraper and a multiple one).

In FN3, the stratigraphic sequence, 5 m thick, comprises calcareous and marl levels deposited in a shallow lacustrine environment, with archaeological levels appearing in the lower 2 m. As at BL, the artifacts (Table 1) were manufactured from the local pebbles, mainly flint. Limestone pebbles without knapping traces have also been observed and interpreted as manuports, although we lack information on whether these stones could be natural and derived from the site's periphery (Toro et al., 2003b).

The FN3 assemblage is made up exclusively of cores and flakes and lacks true core tools or retouched flakes. Some cores were fully exploited, having yielded a high number of flakes. At least one core shows unipolar blade scars, and among the flakes we find several derived from discoid cores and the products of centripetal preparation surfaces, and others with small removals on the proximal dorsal face, a technical feature that could be related to platform preparation. Despite the lack of bifacial implements, some of the small flakes with non-cortical surfaces and a large number of scars could be products of biface maintenance.

Atapuerca (Burgos)

The lower levels (TD4 and TD6) of Gran Dolina, one of the cavities forming part of the Atapuerca karstic complex in the northern Meseta, contain human remains, fauna and stone artifacts. These levels have been dated to the end of the Lower Pleistocene by the identification of the Matuyama/Brunhes polarity change at the base of TD7 (which overlies TD6); the Matuyama-Brunhes boundary was previously located in TD3 (Parés and Pérez-González, 1995; 1999). Since all layers prior to TD7 show negative polarity down to the base of the stratigraphic sequence, all the lower portion of Gran Dolina is dated to post-Jaramillo pre-Brunhes times. Other dates (ESR and uranium series) corroborate these conclusions and fix the age of TD6 between 860 and 780 ka (Falguères et al., 1999; 2001; Bermúdez de Castro et al., 2004). The fauna, and especially the evolutionary stage of arvicolids, are attributed to the end of the Biharian; these paleomagnetic determinations and dates provide, for the first time, a good calibration for this characteristic biochron in Spain (Cuenca-Bescós et al., 2004).

The industry of TD6 comprises 268 pieces, 205 of which can be identified as artifacts (Table 1). There are also five natural blocks, 14 rounded pebbles with percussion traces and 44 pieces that cannot be identified because of their high degree of alteration. This assemblage was excavated from an area of about 6 m^2, a surface constituting approximately 10% of the preserved level; the original extent of this level is unknown, since part of the cave was destroyed in the early twentieth century by the construction of a railway line (Carbonell et al., 1999).

In TD6, the artifact raw materials were mainly Neogene flint and quartzite. Miocene flint of poorer quality, sandstone, quartz and compact limestone are rocks existing in the cave's surroundings and they occur in lower frequencies. Apart from 19 non-worked pieces (some with characteristic percussion marks) and 44 unidentifiable pieces, the assemblage includes 19 cores and tested pebbles, 145 unretouched flakes, 14 flake fragments and 27 flakes with denticulate or scraper edges (Carbonell et al., 1999).

Also recorded are two large flint flakes probably made elsewhere and transported to the cave to be used as blanks. This technological trait, as well as the presence of a quartzite discoid core and several flint flakes derived from cores with centripetal removals, indicates an Acheulian level of technology, in accordance with the age proposed for TD6. However, it has been repeatedly stated that the technical level of this industry should be referred to as "Mode 1" (Carbonell et al., 1999), despite its having been being designated "Developed Oldowan" (Bermúdez de Castro et al., 2004) on other occasions. The complete excavation of the level should provide a larger lithic assemblage on which to base this type of discussion.

Recently, evidence of a lithic industry has also been discovered in the Lower Pleistocene levels of Sima del Elefante. This consists of 25 previously undescribed flint artifacts from the lower stratigraphic unit, for which an age even earlier than that of TD4–TD6 has been proposed, since its association of micromammals is considered to indicate an age of 1.3–1.1 ma, and the presence of the carnivore *Pannonictis nestii* suggests a minimum age of 1.4–1.3 ma (Rosas et al., 2004). Nevertheless, the development during the Pleistocene of the topography surrounding the cave, as inferred from the statistical modeling of successive longitudinal river profiles, indicates that the opening of the cave to the outside and its possible human occupation are coeval with that of Gran Dolina, and cannot predate the fourth terrace of the river Arlanzón ($T4_{AZN}$, at +60/67 m), assigned to the end of the Lower Pleistocene (Benito and Pérez-González, 2005; Pérez-González, personal communication).

The Acheulian of the Middle Pleistocene

Nature of sites and regional distribution (Table 2)

The known Middle Pleistocene sites of the Iberian Peninsula almost invariably appear in fluvial deposits of middle river terraces. From the higher terraces, which have also been intensely explored, there have been no reports of anything but isolated lithic artifacts, often of difficult diagnosis. This situation is primarily determined by the general geological features of the area, which includes vast regions devoid of calcareous formations or significant lacustrine basins. The most notable exceptions

Table 2: Terrace sequences in the Meseta.

Rivers	Lower Pleistocene	Middle Pleistocene	Upper Pleistocene
GUADALQUIVIR	From +212 to +165 (4 levels)	+139 +115 +100 +85 +73 +55 +35	+26 +14 +6/8
GUADIANA	+22/28	+16/18 **+10/13 +8**	+5/6 +3
Jabalón	+45 +40 +31 +25	+19/21 **+10/12 +7**	+2/3
TAGUS (Toledo)	From +125 to +75 (6 levels)	+60 +50 **+40 +25/30**	+15/20 +4/9 +3/5
TAGUS (Talavera)	From +195 to +82 (7 levels)	+60 **+40/45 +25/30**	+18/20 +8 +2/3
Manzanares	+90 +80 +68 +60	+52 +44 +35 **+25/30 +18/20**	+12 +10 +8 +3
Jarama (Aridos)	+147 +125 +99 +82	**Arganda I and II** +52 +40	Arganda III +3/5
Jarama (Talamanca)	From +190 to +65 (11 levels)	+50 +40 +38 **+30**	+12 +8 +3/5
Alto Henares		+55 +40 +33 +25	+16 +9
Alagón	From +125 to +70 (5 levels)	+60 **+40/45** +35 **+26**	+18 +10 +6 +2/4
DUERO	From +144 to +74 (7 levels)	+62 +54 +40/48 **+24/30**	+18 +8 +3/5
Tera	–	+35 **+20**	+12 +7 +3
Pisuerga	+130 +105 +80 +70	+60 **+40 +25/30**	+15 +7 +5
Tormes	+120 +108 +80	+62 +50 +40 **+34 +22**	+10/12 +8 +3/5
Yeltes-Huebra	+60 +40	+25 +18/20 **+8/10**	+5
Eresma	+68	+60 +54 +45 +30 **+26**	+12 +3

Note: Major rivers are in capitals and thick lines separate the major river basins. Relative elevations in meters; levels with Acheulian artifacts are indicated in bold.

are the cave sites of Atapuerca (Burgos) and Bolomor (Valencia), along with those appearing in the lacustrine deposits of the Guadix-Baza depressions (Granada). The sites of Ambrona and Torralba, although in karstic terrain, occur in fluvio-lacustrine deposits. Within a similar general setting, we should mention the caves of Almonda in Portugal (Estremadura), presently under investigation (Marks et al., 2002). It should be noted that in a good part of the calcareous regions of the interior peninsula intensive surveys have not been undertaken, and consequently the situation might change in the future.

There is currently adequate knowledge on terrace systems, providing a reference framework for the chronological ordering and linking of sites. In some cases it has been possible, based on fauna, paleomagnetic determinations and absolute dates, to calibrate the fluvial morphostratigraphic framework.

Some sites appear on the surface of a middle terrace while others are in stratigraphic context, although often in high-energy deposits. Primary context sites have been found in overbank deposits (e.g., Aridos and Arriaga in the Madrid area), in low-energy deposits (Puente Pino, Toledo) and in fluvio-lacustrine deposits (Ambrona and Torralba in the province of Soria).

Very few Middle Pleistocene sites are known in the Mediterranean region, in the middle and lower Ebro basin, in Galicia and on the Cantabrian coast (Santonja, 1996; Montes, 2003). In the Mediterranean region, sites are almost exceptions. This lack of sites could be the result of the irregular discharge regimen of rivers subjected to frequent floods under the effects of the Mediterranean climate, impairing the preservation of sites in fluvial environments (Santonja and Pérez-González, 2001a). The middle terraces of the short Cantabrian and Galician river reaches, subjected to glacio-eustatic sea level changes, are not well preserved, thus explaining the presence of sites only in places where terraces have not suffered the effects of erosion.

The Guadalquivir depression

The Guadalquivir basin is a structurally complex area comprising several units. Besides the Fosa del Guadalquivir, the Neogene depressions east of Granada, particularly the Guadix-Baza basin, are especially important. Though many sites are exclusively paleontological, others, such as those in the Orce area, also have an archaeological record. In Cúllar-Baza I, an area has been identified that contains lithic artifacts (two choppers and six flakes) associated with fauna dated to the middle part of the Middle Pleistocene (Ruiz Bustos and Michaux, 1976). Several years ago an extensive site was uncovered at Solana del Zamborino, close to Guadix; it comprises a broad succession of levels in fluvial deposits of complex interpretation (partly overbank facies), in which an Upper Acheulian industry of the final Middle Pleistocene appeared in association with large mammals (Botella et al., 1976).

In the Guadalquivir terraces, Acheulian industries are known all along the middle and lower reaches of the river, between Jaén and Sevilla, along both the main river and several of its tributaries. The morphostratigraphic sequence of the Guadalquivir in Sevilla is composed of 14 levels (Table 2), dated by U/Th and paleomagnetic determinations (Baena and Díaz del Olmo, 1994). The Jaramillo Subchron (ca. 0.99–1.07 ma; Cande and Kent, 1995) is located between terraces T3 (+169 m) and T4 (+142 m), while T5 (+139 m), showing normal polarity, would correspond to the Middle Pleistocene (Brunhes Chron, post-0.78 ma). For T10 (+55 m), a date around 0.3 ma is proposed, and the carbonate deposits at the top of T12 (+29 m) have been dated to 80,000 years.

The first known lithic industries were recorded in T5 and T6 (+115 m), terraces ascribed to the initial stages of the Middle Pleistocene (Caro Gómez et al., 2005). Stone artifacts occur in high-energy gravel levels lacking in fauna. T5 contains not only simple cores and choppers but also retouched flakes, sometimes fairly large, and there is even mention of a Levallois flake. In T6, trihedral picks and a cleaver have been described. If the age proposed is confirmed, we would be looking at an Acheulian industry of around 0.7 ma, a date unparalleled in other fluvial systems of the peninsula. The sequences described show substantial vertical development and since some of the gravel levels containing the artifacts could represent sedimentary cycles developed on the terraces, the industry's age could be more recent.

Other assemblages in the Guadalquivir that include clearly Acheulian bifacial tools are known from T8 to T11. The industry of terrace T12, already into the Upper Pleistocene, would correspond to the Final Acheulian. All these industries are made on local quartzite cobbles; from T10 onward, the fluvial sediments contain flint, which was also worked.

Another important set of sites has been recognized in Guadalete (Cádiz), with an Acheulian industry, also dated to the Middle Pleistocene, being identified in three successive terrace levels (Giles et al., 1989).

The Guadiana basin

Middle Pleistocene sites are found along the entire Guadiana River, but mainly in Campo de Calatrava. This Tertiary depression underwent some volcanic activity during the Pliocene and the beginning of the Quaternary, but there are no records of human fossils or artifacts of this age.

During the Lower Pleistocene, drainage of the eastern sector (Alto Guadiana) towards the Mediterranean occurred through today's Júcar valley (Pérez-González, 1994). The terraces associated with this situation have provided faunal remains (Mazo et al., 1990), but so far there are no signs of human occupation.

The downcutting of the Guadiana in the Quaternary was notably less than that of the Guadalquivir, Tagus or Duero rivers, and consequently the relative heights of the terraces are lower here than those in the other basins. The middle levels of the Guadiana and Jabalón rivers contain Acheulian artifacts. The most representative localities are El Martinete (+10/13 m) and Albalá (+8 m), both in the Guadiana valley, where similar frequencies of bifaces and cleavers are found (Table 3). These cleavers, made on cortical or simple flakes, are mainly of types 0 and II, with some type I pieces and pieces with invasive bifacial retouch approaching type V (Figure 2; Tixier, 1956; Balout et al., 1967). The El Martinete assemblage includes a type III cleaver manufactured from a Levallois flake, a method only sporadically used. None of these terraces contain fauna and an age somewhere in the second half of the Middle Pleistocene is suggested only by their relative position in the general sequence (Santonja and Pérez-González, 2002).

The Porzuna site is located on a terrace at +5 m in the headwaters of the Bullaque River, a tributary of the Guadiana. Collections of quartzite artifacts, obtained from the surface and amounting to over 5000 pieces, have been analyzed and described as Upper Acheulian (Vallespí et al., 1985). Cleavers are common in this site (475 specimens), their frequency being two to every three bifaces. The artifacts show different features from those observed in Albalá and El Martinete and, although there is still a predominance of items of types II (45%), 0 (25%) and V (18%), type I (5%) is also represented. Types III (6%) and VI (2%), made on Levallois and Kombewa flakes respectively, are more frequent than in the other sites. The morphotechnical characteristics of the bifacial tools (regular shapes, edges frequently retouched by soft hammer) are comparable to those observed in El Basalito (Salamanca) and in the complex terrace of Butarque (Manzanares valley, Madrid), sites discussed below.

Sites along the middle reaches of the Tagus

The discovery and investigation of Pinedo (Querol and Santonja, 1979) and other sites near Toledo

Table 3: Stone artifacts of several sites in fluvial context.

Artifacts	El Martinete	Albalá	Pinedo	Puente Pino	Sartalejo	Arganda I
Non-cortical flakes and fragments	29	16	2812	266	1166	74
Cortical or partly cortical (>50%) flakes and fragments	20	13	1204	101		
Tools on flake	16	33	271	41	341	14
Flakes with some retouch	9	32	227	77	238	6
Heavy-duty tools on flake	14	3	n.d.			2
Cores and fragments	29	15	261	56	848	15
Retouched cores	1		2	2	n.d.	0
Small tools on pebble	0	5	5	0	0	0
Choppers	9	7	985	6	91	4
Bifaces	17 (50% on flake)	30 (13 % on flake)	72 (27% on flake)	8 (20% on flake)	145 (>50% on flake)	14 (36% on flake)
Biface fragments	0	0	2	0	15	0
Flake cleavers and similar pieces	type 0=5 type I=1 type II=8 type V=2 T.A.=1	type 0=10 type I=6 type II=11 type III=1	type 0=25 type I=7 type II=3	type 0=1 type I=1 type II=2 T.A.=1	type 0=214 type I=28 type II=60 type III=2 type V=15 type VI=4 T. A.=5 Others=15	type 0=4 type I=1 type II=1 type III=1
Trihedral picks	5	3	66	3	26	3
Total	**166**	**185**	**5943**	**565**	**3213**	**139**

Note: Cleaver types are those of Tixier (0–V). Type T.A. refers to a unifacial or bifacial cleaver similar to those described at Terra Amata, in which the distal working edge is obtained by a single "cleaver" or "tranchet" blow (Villa, 1983).

containing Quaternary fauna had a strong impact on studies of the Lower Paleolithic in Spain, resumed, after a long interval, from the 1960s.

Immediately upstream from Toledo, a gravel quarry opened in a middle terrace of the right bank of the river Tagus (+25/30 m) showed a density of artifacts among the greatest known in the Iberian Peninsula. Judging from the data obtained from the 25 m^2 excavated and during the subsequent quarry works (30 hectares), the density of artifacts is some 50 per m^3 in gravel and sand levels, with a mean thickness of 3–4 m. This represents an impressive overall number of artifacts. Collections of over 12,000 artifacts have been deposited in the Museo de Santa Cruz (Toledo).

The Pinedo terrace occupies a middle to low position in the sequence of 13 levels of the Tagus in Toledo (Table 2). Faunal remains and reverse paleomagnetic determinations situate the +60 m terrace at the end of the Matuyama Chron (ca. 780 ka), while the faunal record of the +25/30 m terrace indicates an advanced Middle Pleistocene age (Soto, 1979). The +50 m and +40 m terraces might also correspond to this period. In the +40 m terrace, *Mammuthus trogontherii* and micromammal

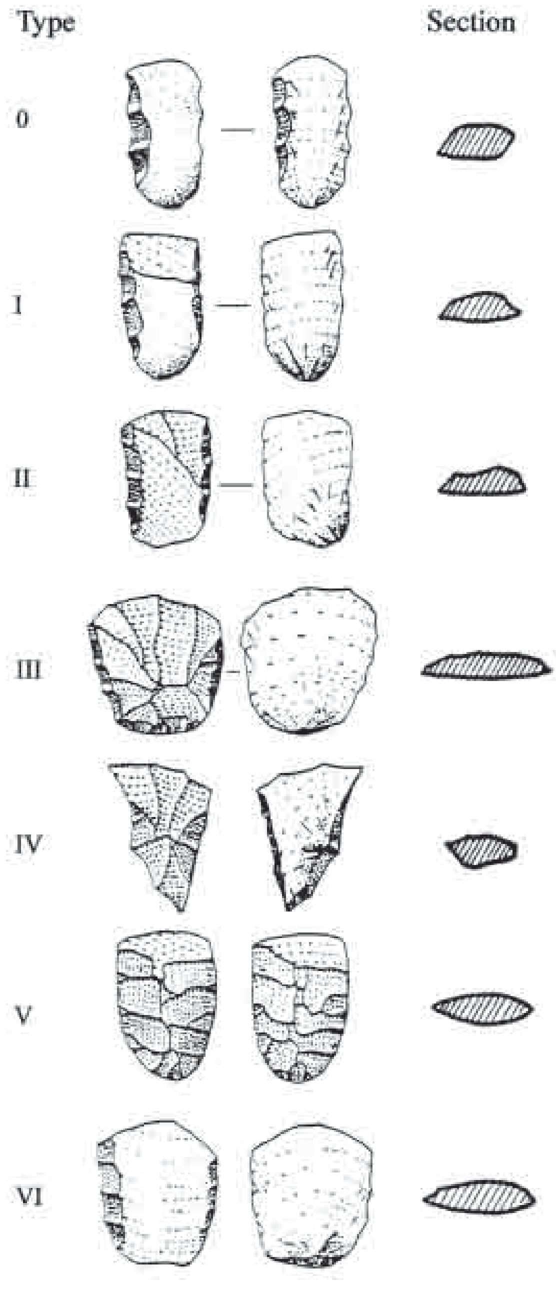

Figure 2: Typology of cleavers according to J. Tixier (1956; Balout et al., 1997). Following Tixier's definition, cleavers are tools on large flakes, shaped by retouch on the sides and with a wide cutting distal edge without retouch. Type 0 = on a cortical flake with the distal edge formed by the intersection of the cortical dorsal face and the ventral face, without prior preparation; type I = on a cortical flake but with the distal edge formed by a removal on the core, prior to the extraction of the cleaver flake; type II = on an ordinary flake; type III = on a Levallois flake; type IV = Tabelbala–Tachengit type, with both sides configured by prior removals on the core, without retouch; type V = with invasive retouch; type VI = on a Kombewa flake.

taxa suggest an age comparable to that of Cúllar-Baza (Granada) and older than the Aridos sites (Sesé et al., 2000). This leaves open the possibility of chronological equivalence between the Pinedo site and the Jarama sites.

The industry of Pinedo is in secondary context, in fluvial deposits of medium energy. In technological terms, the Pinedo assemblage (Querol and Santonja, 1979) contains many scarcely exploited cores with isolated, independent, multidirectional or bifacial removals from a single edge. The most organized forms are discoid cores, with no evidence of Levallois flake production, or at least no preferential Levallois cores. In the series excavated in the 1970s (Table 3) there are very few flakes with intensive retouch. Tools were shaped mainly on pebbles to obtain choppers, trihedral picks and bifaces, many made with large removals without edge retouch. However, there are cleavers, about half the number of bifaces; they are mainly of type 0 (71%) but also of types I (21%) and II (8%). The apparent archaism of the Pinedo industry should not be interpreted in evolutionary terms, since sites such as San Isidro, Aridos, Sartalejo or La Maya II, of comparable age, show more complex technological features, and particularly bifacial tools of more symmetrical form (Santonja, 1996).

The only lithic artifacts detected in higher levels of the Pinedo terrace sequence (apart from several doubtful artifacts found in a +75/80 m terrace at El Espinar) are a few isolated pieces, i.e., a polyhedral core and some flakes in the +40 m terrace.

In Talavera de la Reina, 80 km downstream, the fluvial sequence (Pérez-González et al., in press) is very similar to the Toledo sequence (Table 2). Several sites are known in this sector, apparently situated on the +40/45 m terrace, though it cannot yet be ruled out that these sites are related to alluvial fans more recent than the terrace and similar in age to Pinedo. A small sample, consisting of 14 artifacts including at least one thick, sub-oval biface and a cleaver produced on a simple flake, was obtained from the stratigraphic section of Hornaguera (Malpica de Tagus). A more extensive site is Puente Pino (Alcolea de Tagus), currently under excavation (Rodríguez de Tembleque et al., 2005). The main level excavated at this site contains a lithic assemblage in a sand level lacking associated fauna and covered by fine-grained, low-energy deposits. There are hammers, cores and flakes of all types, choppers, bifaces, cleavers and tools on flake (Table 3) made of local rocks, mostly quartzite but also quartz and flint.

The Alagón valley

In the area of the confluence of the Jerte and Alagón rivers near Cáceres, other Acheulian assemblages are known, especially from the +26 m terrace (Santonja, 1985; Moloney, 1992), a position similar to that of Pinedo (Table 2). In the absence of fauna or dating of any kind, the morphostratigraphic sequence is the main criterion for correlations with sites in the same catchment area.

Although the first indisputable human artifacts (a discoid core and several flakes at the Argeme chapel) once again appear in the terrace at +40/45 m, El Sartalejo (Galisteo), on the +24/ 26 m terrace, offers the largest assemblage of the Alagón River, comprising 3213 artifacts (Table 3; Figures 3–5). This time the number of cleavers is double that of the bifaces, also often made on flakes; the cleavers correspond to types 0 (52%), I (7 %), II (23 %), III (1 %), V (4%) and VI (2%). A further 9%

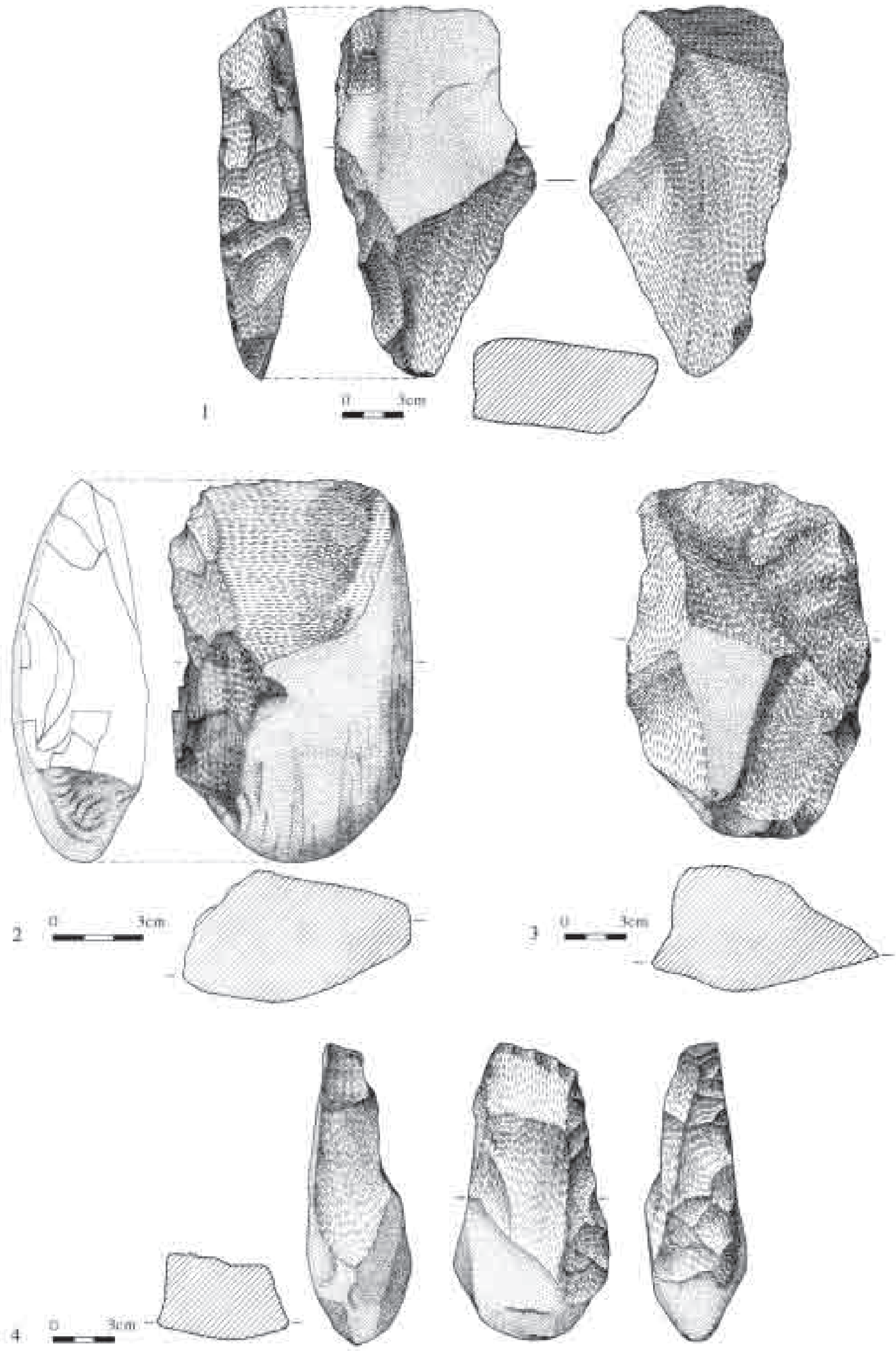

Figure 3: Quartzite cleavers from El Sartalejo (Spain). (1) type 0, an atypical piece since the cutting edge is formed by the intersection of the cortical dorsal face with a ventral face that has a large removal present on the core before extraction of the flake; (2–4) cleavers of the Terra Amata type (Villa, 1983: 122–123).

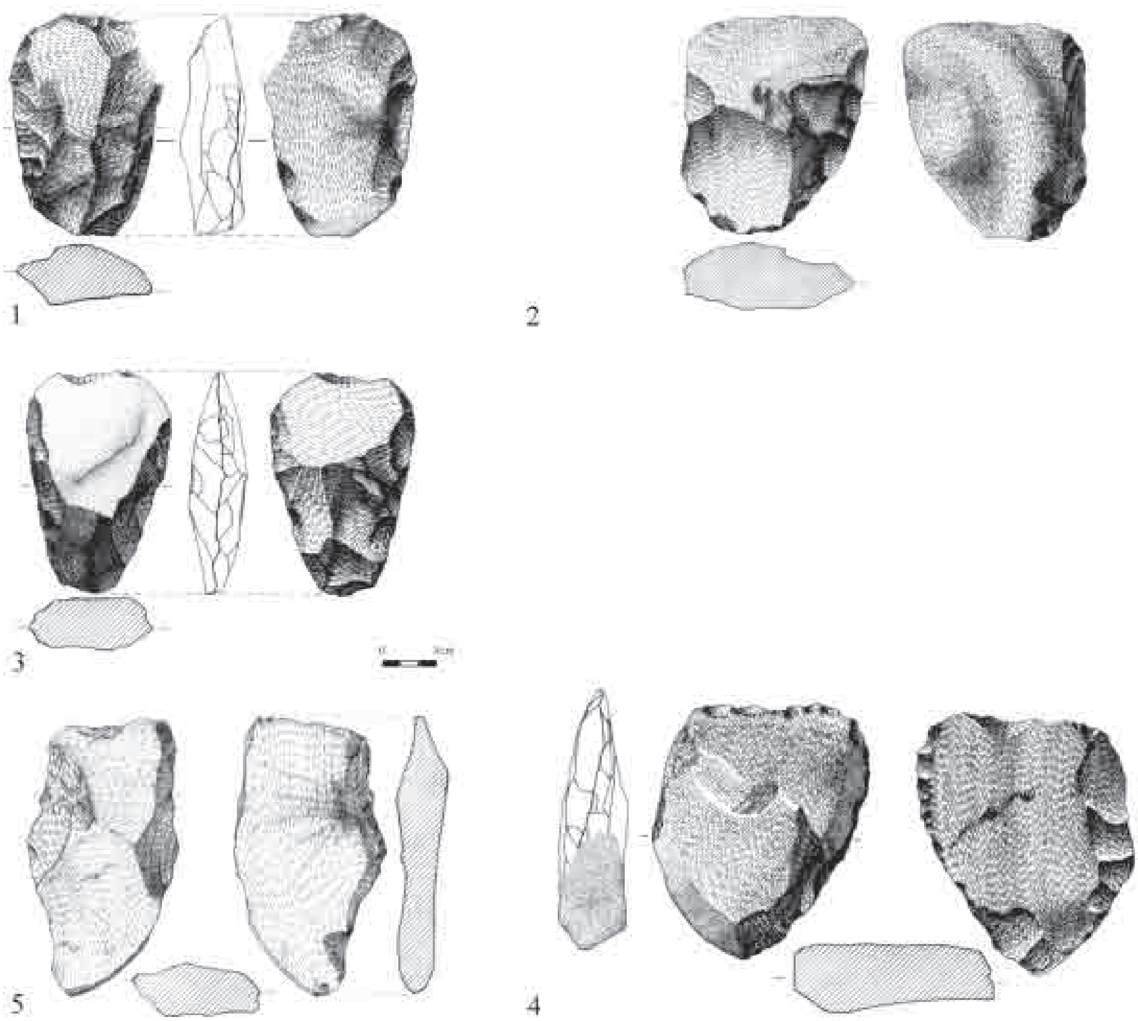

Figure 4: Quartzite cleavers from El Sartalejo (Spain). (1) type III; (2) type VI; (3) could be classified as intermediate between type 0 and type V, since this piece has bifacial invasive retouch; (4–5) cleavers on special flake.

show signs of invasive retouch on the upper surface, precluding reliable identification of the blank. Another three pieces were made on the core itself. There are also examples of cores specifically prepared for manufacturing this type of cleaver, a flaking procedure making them approximately equivalent to Tixier's type IV, despite the different preparation method. The average length of this set of artifacts is 140–150 mm and their average weight is about 650 g. These figures are appreciably higher than overall values recorded for the middle terraces of the Guadiana (125/135 mm and 500 g) or Pinedo (110 mm and 340 g). The size of the raw materials may have influenced the higher frequency of cleavers observed in El Sartalejo, which is higher than in any other Meseta site (Santonja, 1985).

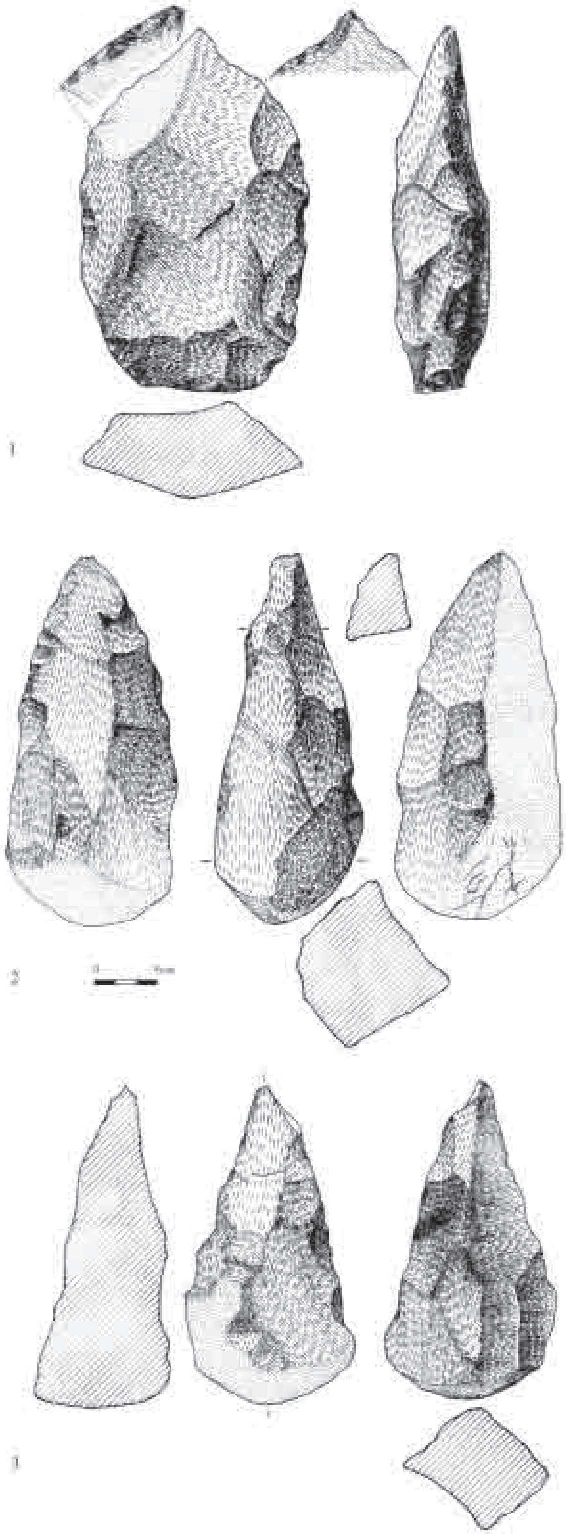

Figure 5: Quartzite cleavers from El Sartalejo. (1) type II, with borer retouch on the distal edge; (2–3) trihedral picks.

The comparison with Pinedo is interesting, since some technological differences are quite marked. In Pinedo, the Levallois strategy seems totally absent, while El Sartalejo yielded Levallois cores and flakes, some of rather large size. At both sites, discoid cores account for a third of the total number of artifacts. In El Sartalejo, striking platforms were more frequently prepared, though in a simple manner: dihedral butts comprise 11%. Cores with large removals (often only one) suitable for manufacturing cleavers and bifaces are common in El Sartalejo but absent from Pinedo.

Tool shaping processes differ to an even greater extent. In El Sartalejo, tools made on flakes of smaller size fall into standardized patterns, as a consequence of a more regular and systematic use of retouch. There are even flat bifaces, often made on flakes, and although the method of direct percussion without secondary trimming of edges (to produce bifaces of "Abbevillian" style) is common in both sites, profiles and edges tend to be more regular in bifaces from El Sartalejo. Cleavers are more elaborate at El Sartalejo; there are pieces with very symmetrical outlines, sometimes on Kombewa or Levallois flakes, and pieces that were completely predetermined on the core before removal.

These differences could in fact be due, at least in part, to the different origins of the two assemblages. The El Sartalejo assemblage originated in the systematic survey of 9.2 hectares of a terrace dismantled by agricultural activity, while that from Pinedo was recovered during the excavation of a small portion of a terrace, some 25 m^2. A quick glance at the collection of Martín Aguado, over 7000 pieces collected during the exploitation of the large Pinedo quarry, suggested that these differences would be less obvious had we used this collection in our comparison, especially in terms of the configuration of tools made on flake and bifaces.

The Madrid region

From 1916 to 1934, the Manzanares River was a focus of archaeological attention. This explains the large number of identified sites, although when talking about this region we should really talk about collections of material, since few of the Madrid area sites have been well defined and systematically excavated.

The middle and low terrace deposits of the last reach of the Manzanares River, spanning some 22 km from San Isidro in downtown Madrid to the confluence with the Jarama, contain the highest concentration of Paleolithic sites known in the Iberian Peninsula. The high density of remains was undoubtedly favored by the synsedimentary subsidence processes that affected the lower stretch of the valley since the Middle Pleistocene (Pérez-González, 1980), leading to a greater deposition of fine-grained floodplain sediments. In these deposits, whose thicknesses exceed ten meters from San Isidro onward, faunal and lithic remains are much better preserved than in the gravel terraces of the other rivers of the Meseta or even of the Manzanares itself north of Madrid.

Upstream from Madrid, the terrace sequences of La Zarzuela and La Casa de Campo (Table 2) are well preserved. At these points, 13 perfectly stepped levels have been identified, an arrangement that is not maintained beyond San Isidro, from which point these levels start to overlap. However, terrace planes can still be distinguished at +8 m, +12/15 m, +18/20 m and +25/30 m, and are better preserved on the right bank of the river. The deposits finally accumulate as a complex terrace east of Madrid, in the last reach of the Manzanares before its confluence with the Jarama (Goy et al., 1989).

The most outstanding Acheulian sites, such as San Isidro, Transfesa and Orcasitas (Santonja and Pérez-González, 2002), are found in the +25/30 m terrace and have yielded Acheulian industry and fauna characterized by *Paleoloxodon antiquus*. In those sites, single elephant carcasses were recovered in low-energy deposits, but it has not been possible to associate them securely with the lithic industry or detect other signs of human intervention (Santonja et al., 2001).

Though several thousand artifacts from San Isidro are preserved in Madrid's museums, the stratigraphic origin of these materials, obtained by several collectors from the late nineteenth century up until 1936, is not precisely known. Flint is the most common raw material. The proportion of cleavers (23 out of the more than 5000 artifacts comprising the collection of the Museo Arqueológico Nacional de Madrid) is much lower than that of bifaces (191). This ratio of ca. 1:8 is much lower than proportions observed in the rest of the Meseta, where quartzite is almost exclusively used. The Tafesa site on the same +25/30 m terrace, where flint is also predominant, shows similar proportions: two cleavers versus 22 bifaces in an assemblage of 297 artifacts (Baena and Baquedano, 2004).

In the area at the confluence with the Manzanares, the intermediate and low terraces of the Jarama, rather than being stepped, overlap each other (Pérez-González, 1994) in a cut-and-fill pattern, as do the terraces of the last reach of the Manzanares. In the Arganda plain, all deposits subsequent to the +40/41 m terrace accumulate as a complex formation, topping at +15/20 m, in which the stratigraphic units Arganda I, II, III and IV have been described (Pérez-González, 1980).

Arganda I, which includes the Aridos sites (Santonja et al., 1980; Villa, 1990), has provided Acheulian assemblages made on flint and quartzite (Table 3). Based on its faunal association, this formation is considered equivalent in date to San Isidro and Pinedo (Santonja and Pérez-González, 2002). In Aridos 2, bifaces and cleavers have been found in probable association with the remains of a single elephant. This association is more evident in Aridos 1, where refitting links completely overlap the remains of the elephant carcass. In Aridos 1 flakes derived from retouch and maintenance of the edges of two bifaces have been identified, but there were no cleavers. The ratio of bifaces to cleavers is about 2:1 in Arganda I, where 14 bifaces and seven cleavers were observed in a series of 163 artifacts. In the younger stratigraphic unit (Arganda II) sites are currently under study (J. Panera, personal communication).

Several other sites are known in the complex Butarque terrace of the Manzanares, whose ages according to the microfauna of unit IIa (Sesé and Soto, 2000) are estimated as final Middle Pleistocene, younger than Aridos and San Isidro. In these levels, typical Levallois products, including both flakes and cores, are documented. Cleavers made on Levallois and Kombewa flakes seem to be most common, although inferences from these selectively sorted series can only be tentative. Also abundant in these series are well-shaped bifaces with secondary edge trimming (Rus and Vega, 1984).

The Duero basin

The Acheulian is present throughout the entire region. The region's western half shows a higher density, perhaps as a consequence of the better preservation conditions offered by the fluvial formations of this zone. Acheulian artifacts are found in the middle terraces of the region's main rivers, especially in the center and west of the basin, from the Esla to the Pisuerga in the northeast and in the Tormes, Yeltes-Huebra and Águeda valleys in the southeast (Santonja and Pérez-González, 2002; Martín Benito, 2000). Sites are also known on the eastern side (Rodríguez de Tembleque et al., 1999) and in the vicinity of Valladolid and Burgos (Díez Martín, 2000). In most cases, in contrast to the situation in the Tagus basin, the artifacts are found on the surface; faunal remains have almost never been found in these terraces.

Acheulian assemblages based on the almost exclusive exploitation of well-rounded quartzite cobbles are mainly found in the middle terraces (Table 2); there has been mention of isolated pieces (flakes and choppers) in levels at +60 m and +80 m, but always very few pieces of doubtful human manufacture.

In the north of the region, the major concentration of industry has been observed in the Esla-Orbigo-Tera confluence zone and along the Pisuerga River. Along the middle to high reaches of this river, in the provinces of Burgos and Palencia, an extensive area of some 2500 km^2, covering 60 km of valley, has been systematically and intensively explored (Arnaiz, 1991). Twenty-five surface sites were identified, one every 10 km^2.

In the Tormes valley, the sequence of terraces in the middle course of the river has been established in detail between Salamanca and La Maya (Table 2; Santonja and Pérez-González, 1984). Acheulian assemblages have been stratigraphically related to the terraces at +32 m (La Maya II), +22 m (Azucarera de Salamanca) and +18 m (Galisancho). Some have also been observed on the surface of higher levels, though not within fluvial deposits. More recent series including small bifaces and various flake tools have been reported in the lowest levels at +8 m and +12 m (Calvarrasa I, La Maya I).

In La Maya II, as in other Acheulian assemblages of the zone, flakes larger than 15 cm are common and were used to make bifaces and large cutting tools. Bifaces and cleavers appear in similar numbers (15 and 12, respectively); cleavers correspond to types 0 (N=4) and II (N=8). Among regular cores, discoid cores are more common. They have recurrent removals from a plain or natural striking platform; thus facetted butts are rare.

Towards the west, in the Yeltes-Huebra river valleys, several terraces, whose relative heights over the present channels do not exceed 60 m, form a sequence with its own particular altimetric characteristics (Table 2). Surface concentrations of Acheulian artifacts are found in the terraces at +40 m, +20/25 m and +10/12 m. The most outstanding site in this area is El Basalito, a surface site on the dismantled terrace of a stream known as Valle Tiendas, a tributary of the Yeltes that established a small drainage network starting from the +40 m terrace of the Yeltes (Santonja and Pérez-González, 2004).

The industry of El Basalito warrants particular attention. An excavation of 18 m^2 undertaken in

1987 by L. Benito and J. I. Martín Benito revealed a high concentration of debitage derived from the shaping of bifaces from local quartzite pebbles, as well as five cleavers, choppers, a few cores and a few retouched flakes. In most cases, cores were disorganized and weakly exploited, while some others were slightly more complex discoid forms; Levallois flakes are very rare.

Bifaces (33 complete and 11 broken) constitute the most conspicuous type group. These are generally bifaces *sensu stricto*, although at least three biface-tool combinations (*sensu* Boeda, 2001) are observed, two with secondary retouch at the tip and the other with a denticulate edge. Some of the broken bifaces show retouch subsequent to their fracture. The bifaces are generally carefully made, with pointed forms (lanceolate, Micoquian, subcordiform and amygdaloid); a slight asymmetry, when present, derives from the blank morphology. Most are finished with retouch by soft hammer.

This assemblage represents the complete sequence of shaping procedures, including all the range of expected byproducts, from cortical and subcortical flakes of the initial shaping process, to the final flakes derived from the sharpening and retouching of edges, and comprising pieces reflecting manufacturing error or break through use (fragments of proximal and distal ends). In other words, El Basalito documents both the shaping procedures of bifaces and cleavers and the following stages of use and discard.

In the eastern part of the Northern Meseta, recent surveys (Rodríguez de Tembleque et al., 1999) have revealed sites in middle terraces, in positions equivalent to those recorded in the western sector (Table 2). Along with several surface finds, artifacts have also been discovered in stratigraphic context in terraces at around +30 m. Findings indicate a situation not unlike that of the western half of this region. The lower density of artifacts could be attributed to factors related to the formation and preservation of Pleistocene deposits.

Ambrona and Torralba

The sites of Ambrona and Torralba (Soria) are found on a natural pass of the Iberian Range at the eastern margin of the northern Meseta, among three large fluvial basins, the Duero and Tagus, which drain into the Atlantic, and the Ebro which flows into the Mediterranean. Extensive excavations at both sites were carried out by Howell and Freeman between 1960 and 1963 (Howell et al., 1962; Freeman, 1975) and between 1980 and 1983 at Ambrona (Howell et al., 1995). Between 1993 and 2000 geological and archaeological investigations were resumed at both sites by a Spanish team under the direction of Santonja and Pérez-González (Figure 6).

In geomorphologic terms, Ambrona lies on a polje developed on Mesozoic limestones whose base, in contact with clays of the Keuper facies, forms a local erosion level that constitutes the so-called Ambrona Surface, on which fluvial and lacustrine deposits accumulated during the Middle Pleistocene (Pérez-González et al., 1999; 2001b).

In contrast, Torralba, 2.5 km southeast of Ambrona, lies on the edge of a doline 6–7 m deep in the +35 m terrace of the Masegar. This stream, a tributary of the Jalón, carved its own valley starting from the Ambrona Surface, which lies at a height of +39–40 m above the bed of the Masegar River.

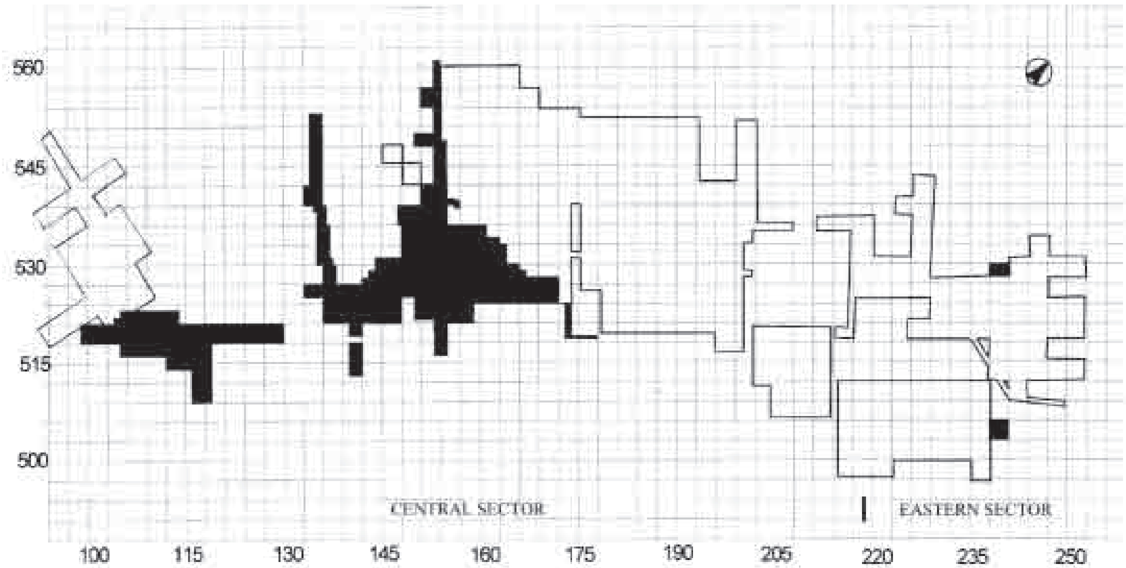

Figure 6: Plan of the Ambrona excavations by Howell (1960–1963 and 1980–1983, in outline) and by Santonja and Pérez-González (1993–1999, in black). The distance between grid lines is 3 m.

During the Middle and Upper Pleistocene, the stream built a polycyclic valley, with rocky terraces at +35 m, +22 m, +15 m and +7–9 m, and an alluvial plain at +1 m. Thus Torralba occupies a position lower than the +35 m level and is clearly younger than Ambrona (Pérez-González et al., 2001b). In other words, the two sites do not belong to the same stratigraphic formation, as proposed by Butzer (1965); they occupy distinct geomorphologic positions and have different ages.

Correlation of the Masegar terraces with the upper Henares and Jalón terraces suggests that Torralba is older than T4, the +22 m terrace of the Henares, whose travertine formations have been dated between 243±18 ka (^{230}Th/^{234}U) and 202±18 ka (^{234}U/^{238}U). Ambrona may be correlated with T2, the +40 to 45 m terrace of the Henares dated to >350 ka (^{230}Th/^{234}U; Pérez-González et al., 2001b; Howell et al., 1995).

The macrofaunal remains do not discriminate between the two sites of Ambrona and Torralba. When considered in the Iberian context, both sites would be later than Cúllar-Baza and the faunas of the +40 m terrace of the Tagus in Toledo (Buenavista, Campo de Tiro). Ambrona's microfauna (which Torralba lacks) are older than the top levels of Atapuerca's Gran Dolina and Galería (Sesé and Soto, in press).

Both the Ambrona and Torralba sites show a complex stratigraphy. The Ambrona deposits were divided by Howell into the Lower and Upper Member Complexes, and these subdivisions are retained here for convenience. The Lower Member Complex was excavated by Howell over more than 2088 m^2, while the Upper Member Complex was excavated over 909 m^2 (Howell et al., 1995: fig. 4). The total area excavated by the Spanish team between 1993 and 2000 is 706 m^2, of which 648

Table 4: Ambrona: stone artifacts by level (excavations carried out in 1993–2000 by the Spanish team in the central sector of the site).

Level (excavated surface in m²)	**AS1** (580)	**AS1/2** (195)	**AS2** (195)	**AS2/3** (ca 2)	**AS3** (250)	**AS4** (379)	**AS5** (8)
Non-cortical flakes	25	1	6		11 (6)	76	1
Non-cortical flake fragments	39	2	3		13 (1)	83	1
Cortical or partly cortical flakes	23				6	24	
Cortical or partly cortical flake fragments	14		1		3	27	
Small tools on non-cortical flake	25	6		1	13 (4)	41	2
Small tools on cortical flake	19	1			4	10	
Cores	19				4 (1)	15	
Cores on flake	2				2 (2)		
Retouched cores	1					3	
Chunks	40	3	4	1	10 (2)	56	2
Small tools on pebble	4					1	
Choppers	6					1	
Modified pebbles	1						
Hammers	8				4 (?)	1	
Bifaces	5				2 (2)	1	
Biface fragments	1						
Flake cleavers and similar pieces	2	1					
Trihedrals	1						
Total: 682	**235**	**14**	**14**	**2**	**72**	**339**	**6**

Note: Artifacts showing no signs of edge rounding (edge rounding=0) in AS3 are in parentheses. AS1 here includes artifacts from the sandy channel deposits excavated in 2000 in the northern part of the site; thus totals are different from those provided in Villa et al., 2005, where the channel deposits were not included. AS4 was excavated over a total area of 630 m² but only the detrital facies provided artifacts and bones.

m² were in the central sector of the site. The area excavated in each level in the central sector of the site is provided in Table 4.

The geomorphology and lithostratigraphy of the so-called Lower Member Complex at Ambrona have been described in detail by Pérez-González (Pérez-González et al., 1999; 2001b); the sequence comprises six sedimentary units (AS1 to AS6) of fluvial and fluvio-lacustrine origin. Taphonomic processes in the lower stratigraphic units AS1 to AS4 have been analyzed in Villa et al., 2005.

The lithic industry of all levels at Ambrona is made on several varieties of flint and silicified limestone, quartzite, quartz and limestone. Limestone is present in the nearby surroundings, but all other raw materials are allochthonous and were transported by humans into the site. Based on collections stored in Spanish museums, the field seasons of F. C. Howell and L. G. Freeman yielded 3150 artifacts (Panera and Rubio, 1997), i.e., 1276 from the Lower Member Complex (which appears to correspond mainly to units AS1, AS3 and AS4, as defined by Pérez-González) and 1874 from the Upper Member Complex. The first set includes 43 bifaces and seven cleavers manufactured on ordinary or cortical flake, sometimes with bifacial invasive retouch resembling type V. In the Upper Member Complex, the numbers of bifaces and cleavers drop to 17 and two respectively. One of these cleavers was made on a Levallois flake and the proportions of implements with retouch and Levallois debitage are much higher. The overall picture of assemblages from two distinct stratigraphic complexes in Ambrona should be treated with caution. Aside from their potential age differences, we need to take into account other factors related to site formation processes (Santonja et al., 2001).

Level AS1 is an alluvial fan merging into sandy channel deposits in the northern part of the site. It has provided 235 artifacts (Table 4), most of which show clear signs of edge rounding. None of the bifaces observed bear signs of edge reshaping or retouch. Cleavers of type II with reworked edges and type 0 show more than one generation of lateral retouch. Among the debitage there is at least one core with a preferential Levallois surface and flakes typical of those used for preparing further Levallois cores. There are also discoid, polyhedral and unipolar cores. Retouch on flake tools is not intensive; some scrapers were made on exhausted cores. Cortical flakes and small flakes and debris are well represented. Thus debitage and shaping or retouching of bifacial pieces are documented at the site, although some of the large cutting tools may have been introduced ready-made, specifically cleavers, since in this level, as in the others, there are no cores capable of providing sufficiently large flakes to make these implements (Figure 7).

Artifacts are scarce in the succeeding levels AS1/2, AS2 and AS2/3, which are thin and of limited extent. More artifacts have been observed in AS3, though three quarters of the pieces, with edge rounding, could be eroded from lower levels and redeposited. Among the debitage, we find several flakes with good cutting edges. Formal tools are limited to a scraper and a couple of bifaces (one with a transverse edge), although some flakes could be the by-products of maintenance of other bifaces, suggesting a possible greater frequency and use of this type of implement in AS3; this level has yielded important specimens of megafauna (Villa et al., 2005).

Level AS4, also of fluvial origin, shows the largest number of artifacts in the central Ambrona sector, although the mean density of its industry does not reach 1 per m^2 (1–2 pieces per m^3). These lithic artifacts are nevertheless unevenly distributed, depending on the sedimentary characteristics of the level, since lithics have been found almost exclusively in the detrital facies; the artifact sizes are similar to those of the gravels that contain them. The cores appearing in this level are also reduced in size. These are usually exhausted undetermined cores, although a few Levallois flakes are present.

Among the upper levels of the central sector of the Ambrona excavation, only AS5 contains very few artifacts. However, the situation is different in the site's eastern sector. Here, it is common to find stone artifacts in low-energy deposits that are laterally equivalent to level AS6 defined in the central sector. Before this stratigraphic interpretation (Pérez-González et al., 2005; Pérez-González, in press), these levels in the eastern part of the site, constituting Howell's Upper Member Complex (Howell et al., 1995) had provisionally been identified as "AS7" and "AS8" (Pérez-González et al., 1999).

The general characteristics of the so-called Upper Member Complex industry observed in Howell's field seasons of the 1980s (Panero and Rubio, 1977) coincide with our observations of

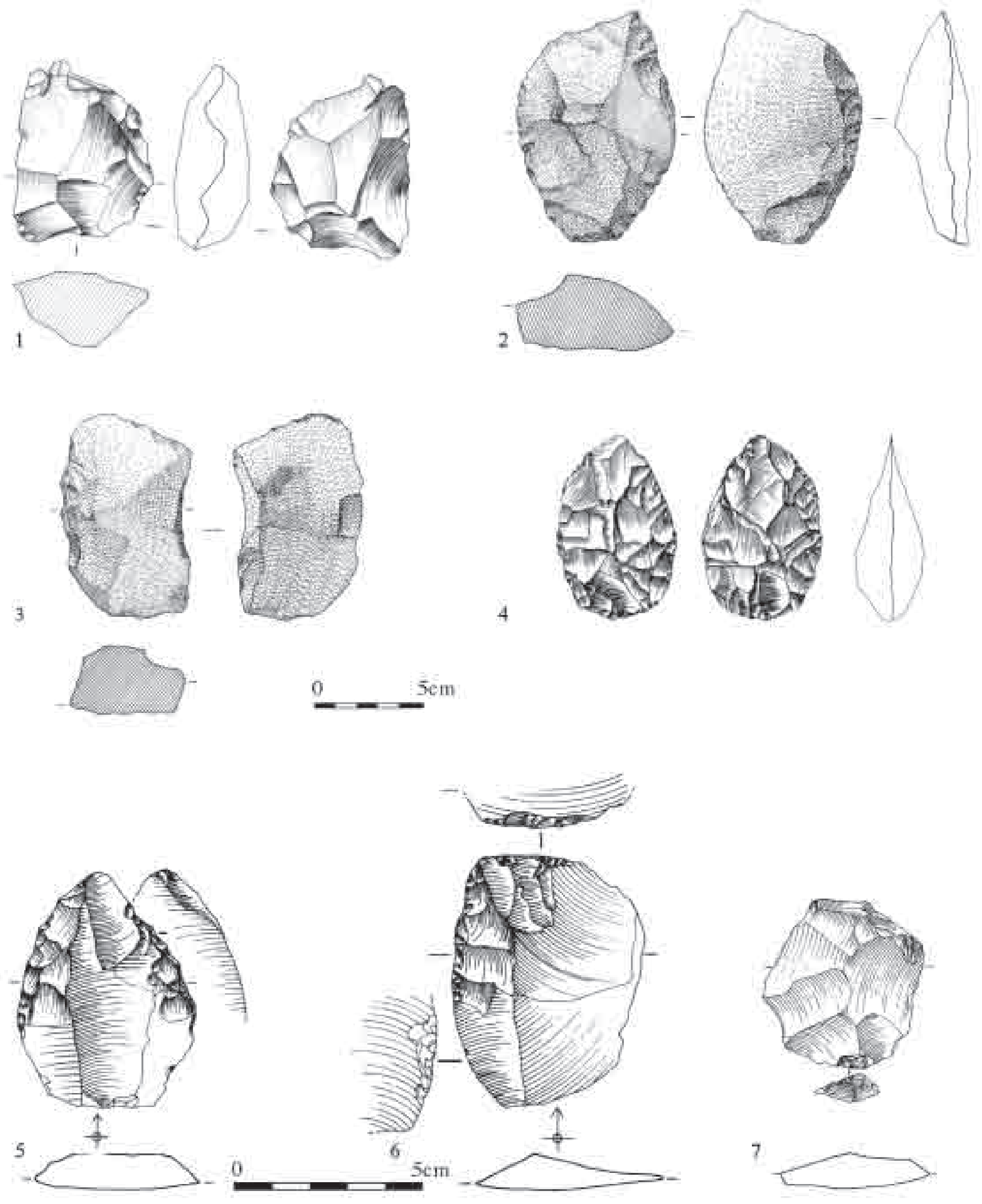

Figure 7: Ambrona, excavations of Santonja and Pérez-González. (1) Level AS1, preferential Levallois core on flint; after removal of the preferential flake the production of flakes continued on the same debitage surface; (2) Level AS1, quartzite cleaver, type II with retouched edge; (3) Level AS1, quartzite cleaver, type I; (4) Level AS3, flint biface with secondary retouch by soft hammer; (5) Level AS6 (eastern sector), double scraper on a Levallois flake; (6) Level AS6 (eastern sector), flint scraper with alternate retouch on the distal edge; (7) Level AS6 (eastern sector), Levallois flake on flint.

1993 and 1994, when we excavated 20 m^2 in levels that can be correlated with AS6. The industry is better preserved here, where debitage is more common, than in the lower levels of the central sector. Altogether 182 lithic pieces were recovered, almost 10 per m^2. This assemblage includes good-quality Levallois products, a high percentage of small tools with side-scrapers and denticulates retouched by soft hammer, and some poorly made bifaces. This sample indicates a refined Levallois technique, with few bifaces and well-made small tools on flake.

At Torralba the first excavations by Cerralbo yielded 549 pieces including 96 bifaces (54 with distal cutting edges), some of which were probably true cleavers (Howell et al., 1962). In the 1960–1963 seasons, Howell and Freeman recovered 887 artifacts (Freeman, 1975: 668–674), although 102 were excluded from analysis due to their advanced degree of rolling. Bifaces and cleavers were in lower proportions than in the Cerralbo sample, which was selectively sorted. According to Freeman, the most frequent cores with organized removals were discoid; bifaces had variable shapes, some with retouch by soft hammer and over half with transverse edges. A reanalysis by Querol and Santonja (1978) identified 14 cleavers, which are made on ordinary flakes and may show a tranchet blow, consistent with observations made at Ambrona. Neither Ambrona nor Torralba have cores capable of providing flakes the size of cleavers. Hence, the intensive retouch generally shown by these tools, uncommon in terrace sites of the Meseta, could be linked to the need to keep them functional in the absence of raw materials from which to make new implements.

In summary, Torralba has an Acheulian industry similar to that of the central sector of Ambrona and to assemblages from the middle terraces of the Spanish Meseta, but of a later age. Indeed, the Torralba industry is more recent even than the upper levels of the eastern Ambrona sector, which contains an industry with Levallois debitage and highly standardized flake tools never observed in the open-air Acheulian sites of the Meseta.

Summary of the Spanish evidence

The earliest sites

Atapuerca (the lower levels of Gran Dolina and Sima del Elefante) and two localities in Orce, Fuentenueva 3 and Barranco León, are the only sites in the Iberian Peninsula for which fauna, absolute dating and paleomagnetism are available to establish a Lower Pleistocene date, of post-Jaramillo age in the former case and possibly older in the latter. The archaic age assigned to several sites along the Portuguese Atlantic coast has not been corroborated in the most recent reviews (Raposo, 1985). This is also the case for river valleys, since true sites are known only in the middle terraces (Santonja and Pérez-González, 2002).

There seems to be a very low density of sites in southern Europe before the appearance of the Acheulian (Carbonell et al., 1995; Oms et al., 2000). To be sure, we cannot as yet completely exclude the possibility that the lack of sites in river valleys during the Lower Pleistocene was due to a preference for other less well-researched environments, such as caves and lake margins.

The ages proposed for all these early sites fall well within the time frame established for the

Acheulian in Africa and western Asia. Despite this, and because these rather small assemblages lack bifacial tools, the excavators of the sites of Atapuerca and Orce have preferred to assign the industries to "Mode 1" or more explicitly to Oldowan industries (Carbonell et al., 1995; Turq et al., 1996; Toro et al., 2003a).

The existence of industries corresponding to a pre-Acheulian level of technology in Iberia at 1.2/0.8 ma would undoubtedly be anomalous. The temporal and human evolutionary distance separating these occurrences from the African Oldowan is extensive. More importantly, we should consider the chronologies of the geographically closest Acheulian sites, such as 'Ubeidiya and Gesher Benot Ya'aqov in the Jordan Rift Valley, dated to 1.4 and 0.8/0.7 ma respectively, and Thomas-1 in Casablanca, with an estimated age of final Lower Pleistocene (Bar-Yosef and Goren-Inbar, 1993; Goren-Inbar and Saragusti, 1996; Geraads et al., 2004; Sahnouni et al., 2004). The presence of industries representative of a pre-Acheulian technological stage within the Acheulian time range should be treated with caution when not based on strong dating evidence and on the study of coherent and representative assemblages.

If confirmed, the chronologies of Fuentenueva 3 and Barranco León would allow us to speculate that the group of hominins involved may not belong to the species *antecessor/heidelbergensis*, whose origin is ascribed to ca. 1 ma (Bermúdez de Castro et al., 2004). We cannot exclude the possibility that it was *Homo erectus*, as has been suggested for Sima del Elefante (Rosas et al., 2004).

The Acheulian of the Meseta

The Acheulian assemblages known in the Tagus and Guadiana basins occur in very specific terrace levels (Table 2), thus corresponding to a limited time range. The situation is less clear in the Duero basin, where Acheulian industries most often occupy a surface position. Nevertheless, the Duero assemblages are also mainly correlated to middle terraces at heights equivalent to those of the Tagus, so that we may be looking at the same time interval. The differences in surface (Duero) or stratigraphic (Tagus and Guadiana) positions could reflect a temporal difference in aggradation and incision processes between these hydrographic basins, which in the Meseta are fundamentally controlled by structural, lithological and tectonic factors.

In Toledo, where there are faunal remains in several successive middle terraces (Sesé et al., 2000), the first traces of an Acheulian industry appear in the +40 m terrace, along with fauna characterized by the presence of *Mammuthus trogontherii* and absence of *Paleoloxodon antiquus*. The development of Acheulian industries occurs in the subsequent terrace (Pinedo), together with remains of *P. antiquus*, a species also found in many of the Manzanares and Jarama sites and at Torralba and Ambrona in association with Acheulian technology. Bearing in mind the age we propose for Ambrona (prior to ca. 350 ka), the expansion of the Acheulian industries of the Iberian Meseta might be dated at around ca. 400 ka, although its onset would be earlier, at the +40 m terrace of the Tagus. The Acheulian persists during the second half of the Pleistocene, although its duration has not yet been determined.

This Acheulian technology was to extend throughout the Iberian Meseta at a late time relative to its African origins. It represents a unitary phenomenon dominated by bifaces and cleavers and whose stages cannot be differentiated in evolutionary terms. The variation observed appears to be related to the available raw materials and the nature of sites. For instance, in sites such as El Sartalejo, the size of available pebbles facilitated the production of large flakes used as blanks for bifaces and cleavers. The Aridos 1 assemblage, lacking bifaces but including the typical flake byproducts of curating this type of tool and containing few retouched flakes and some with limited retouch, is a clear case of how site activities configure the assemblage composition.

On the technological front, the shape of quartzite cobbles (the most common raw material in the Meseta) promotes the radial exploitation of the debitage surface, with only limited preparation of the periphery forming the striking platform. This strategy gives rise to a recurrent centripetal discoid method which in some cases approaches the Levallois concept in a broad sense; cases of predetermined preferential removals are few. The flakes produced in these debitage sequences most often have cortical or plain platform and also dihedral butts.

The end of the Acheulian in the Meseta

Spain's open-air sites do not provide good data for understanding the decline and replacement of the Acheulian industries. In the Guadiana, Tagus and Duero basins there are reports of assemblages described as Upper Acheulian. Examples of such cases are Porzuna, Arriaga and El Basalito, in which bifacial tool manufacture includes edge reshaping and retouch, procedures that are infrequent in previous Acheulian series. At Porzuna and El Basalito, which lack associated fauna, only their morphostratigraphic position suggests an indeterminate Middle Pleistocene age. In Arriaga, and in other sites of the complex terrace of Butarque in the Manzanares valley, the faunal record shows that we are still in the Middle Pleistocene, with micromammal associations younger than those of Aridos I, although *Paleoloxodon antiquus* continues to be present, being replaced in levels immediately above this complex terrace with *Mammuthus primigenius* (Sesé and Soto, 2000).

Nevertheless, there is some evidence pointing to occurrence of assemblages with progressive technological traits attributable to the Middle Paleolithic in time intervals comparable to those of the Acheulian industries. The most significant example from an open-air site is the industry of the upper level (AS6) of the east sector of Ambrona, a site for which an age above ca. 350 ka is considered (Pérez-González et al., 2005). There we see clear evidence of Levallois technology and the standardization of small tools. The upper levels of Gran Dolina and Galería and Bolomor cave (near Valencia) have provided some data that should be taken into account.

Published descriptions for the Atapuerca sites (Carbonell et al., 1999: 346), albeit somewhat contradictory, indicate industries of Mousterian appearance including standardized flake tools and a well-developed Levallois technology in the upper level of Gran Dolina, i.e., TD10 which is dated to OIS 11 to 9; there are average weighted ages of 372±33 ka for the lower part and 337±29 ka for the upper (Falguères et al., 2001).

In Galería, however, the industry, which is described as Acheulian or Mode 2 according to Carbonell, seems to be characterized by centripetal cores, lack of the Levallois technique and strong presence of bifacial tools, sometimes made on flakes (Carbonell et al., 2001). The age of Galería seems to be a little more recent than TD10 and TD11, i.e. 350/300 ka for the base of GII; the entire stratigraphic sequence is placed between OIS 10 and 7 (Pérez-González et al., 2001a; Falguères et al., 2001).

The Bolomor cave, under excavation since 1989 (Fernández Peris et al., 1994), has a sequence of over 10 m, in which 17 levels have been identified and grouped into four stages (Bolomor I to IV). The chronology of this stratigraphic complex would range from 350 ka for level XVII (stratigraphic top) to 100 ka estimated for level I. The three lower stages contain some limestone macrotools but lack typical Acheulian components. Substantial changes occur in the upper Bolomor IV, comprising levels I to VII. The lithic series of level II, dated by TL to 121±18 ka, includes over 15,000 artifacts; about 10% are retouched and the assemblage has been defined as Charentian Mousterian.

The technological progress observed in Dolina and Bolomor appears in open-air sites only at Ambrona level AS6 (east sector), and yet there is a record of Acheulian assemblages, such as Torralba, which are later than those levels at Ambrona. Assemblages described as Upper Acheulian, containing small tools of elaborate types, along the Manzanares (Arriaga and other sites of the Butarque complex terrace) and perhaps in the Guadiana (Porzuna) and Duero (El Basalito) basins, may well date to the end of the Middle Pleistocene and thus be comparable in age to the Mousterian levels of Bolomor.

Italy

The earliest Acheulian

Based on current evidence, the earliest occurrence of Acheulian handaxes in Italy is in the Middle Pleistocene site of Notarchirico in the Venosa basin of southern Italy (Piperno, 1999). Several artifact assemblages are found in fluviatile deposits, rich in volcanic materials, which fill a paleovalley 2–4 km wide. Throughout the Middle Pleistocene the Venosa basin was occupied by a meandering river and witnessed several volcanic eruptions by the Vulture volcano, 23 km to the west. The deposits containing archaeological materials are about 6 m thick and comprise four stratigraphic units (1–4 in descending order). They form an alternating sequence of fluvial sediments filling paleochannels, volcanic ashes reworked by water, and stone pavements formed by detrital slope deposits mobilized by volcanic activity. The fine sediments were then washed out, leaving the pebbles as lag deposits. Thus, the stone pavements represent old land surfaces, with bones and stones forming part of the pavements or resting on top of them (Raynal et al., 1999).

The archaeological sequence consists of nine levels, in descending order levels Alpha, A, A1, B, C, D, E, E1 and F. They have been excavated over variable surfaces, from a minimum of 20 m^2 to a maximum of 133 m^2. Four more levels at the base have only been tested. Levels A, A1, B, D and F have yielded assemblages containing bifaces, made on limestone, flint and more rarely quartzite cobbles. These biface assemblages alternate with assemblages comprising only choppers, cores, flake and

Table 5: Venosa Notarchirico: the archaeological sequence.

Stratigraphy	Date (ka)	Size of excavated area (in m²)	Archaeology
Level *alpha*	359±154/97 Uranium series	60	Human femur (cf. *erectus*); 950 artifacts / no bifaces
Level A		120	316 artifacts / 2 bifaces
Level A1		24 m² preserved	41 artifacts / 9 bifaces
Level B		133	351 artifacts / 10 bifaces
Level C		12	78 artifacts / no bifaces
Level D		15	300 artifacts / 2 bifaces
Level E		18	155 artifacts / no bifaces
Level E 1		20	244 artifacts / no bifaces
Notarchirico tephra	640±70 TL on quartz		Tephra with the same chemical composition on the Vulture volcano is dated 654±11
Level F		30	Artifacts left *in situ*; some bifaces

flake tools (levels E1, E, C, Alpha). At least one assemblage lacking bifaces is rather large (level Alpha at the top of the sequence with 950 artifacts); thus the absence of bifaces is not dependent on sample size (Table 5).

In the biface assemblages we note the absence of flake cleavers, picks, trihedrals, double-pointed bifaces and spheroids. These tool types occur (though not invariably) in Acheulian assemblages of North Africa such as Thomas Quarry unit L, dated to 1 ma (Raynal and Texier, 1989; Raynal et al., 2001) and in Israel at 'Ubeidiya and Gesher Benot Ya'aqov (Bar Yosef and Goren-Inbar, 1993; Goren-Inbar and Saragusti, 1996; Saragusti and Goren-Inbar, 2001). However, two flake cleavers (one on a flint flake) and one subspheroid on limestone were found in the general area of the Venosa basin. Unfortunately, these were surface collections and their age is unknown (Ferrara and Piperno, 1999).

Two levels have yielded a relatively high number of bifaces: level A1, where the bifaces were found in association with an elephant skull, and level B. The bifaces are made on limestone and flint pebbles, occasionally on flake. Only two were made on quartzite. In general the frequencies of raw material for the bifaces are 51% for limestone, 30.2% for flint and siliceous limestone and 18.6% for quartzite. Most of the Notarchirico bifaces are amygdaloids with twisted edges and a low degree of standardization. Based on the published illustrations, their mean length is 13±3.5 cm (N=17).

Assemblages without bifaces and the question of multiple migration events in Italy

It has been suggested that the occurrence of assemblages without bifaces in Southern Europe may indicate two separate migration events. The older dispersal by hominins using only a core and flake technology (called "Mode 1") would include four Spanish sites, i.e., Barranco León and Fuentenueva

3, all dated to about or before 1 ma, Gran Dolina level TD6, dated to 0.8 ma (Bermúdez de Castro et al., 2004b; Oms et al., 2000) and Sima del Elefante, coeval of Gran Dolina (see the section on the earliest sites in Spain). In Italy the two sites of Isernia and Monte Poggiolo have also provided core-and-flake assemblages. The Ceprano skull (see below) is not associated with stone artifacts.

The total excavated assemblage of Monte Poggiolo is 1310 artifacts (1166 flakes and 153 pebbles). Most flakes are smaller than 6 cm and the pebbles are generally 10 cm or smaller. A recent analysis of the Monte Poggiolo evidence suggests that the date of 1 ma remains to be verified and cannot be relied upon to support a precedence of core and flake industries over biface assemblages (Villa, 2001).

Isernia contained four core-and-flake assemblages (Sector I level 3c, level 3a, level 3S10 and Sector II) with 579, 334, 114 and 4524 artifacts respectively. As in the case of Monte Poggiolo, the assemblages are large and hence the small sample size cannot be used as an explanation for the absence of bifaces. The raw material blank size, however, is relatively small, as at Monte Poggiolo. Flint angular blocks and slabs (the main raw material at Isernia) are generally smaller than 8 cm. The occurrence of a primitive form of *Arvicola cantiana*, macrofaunal evidence and new dates of 610±10 and 606±2 ka based on $^{40}Ar/^{39}Ar$ for a layer capping the archaeological deposits at Isernia also indicates a younger age for the site, broadly contemporaneous with Venosa Notarchirico (Coltorti et al., 2005; Villa, 2001). In sum, the early core-and-flake assemblages from Italy have problematic or not very early dates and there is clear evidence of limitations imposed by the size of raw material for the making of bifaces.

However, we believe that another argument needs to be taken into consideration. The alternation of assemblages with bifaces and assemblages without bifaces at Venosa Notarchirico shows that the two technologies (with bifaces or core-and-flake only) are not mutually exclusive. Non-biface industries between 1.6 and 0.5 ma in Africa and western Asia coexisted with Acheulian assemblages in the same stratigraphic sequences and in the same localities. The best-known case is that of 'Ubeidiya (Figure 8; Bar Yosef and Goren-Inbar, 1993), where seven of the 20 reported assemblages do not contain bifacial tools. The excavators rejected the hypothesis that two cultural traditions were present at the site and view all finds as belonging to the same technical tradition. A similar view was expressed by Piperno et al. (1999) for the interstratification observed at Venosa Notarchirico.

Several African sites younger than 1.6 ma demonstrate the coexistence of the two technologies at the same time. In the Middle Awash, two late Lower Pleistocene sites (BOD-A5 and BOD-A6) dated to 1.5–1.3 ma have yielded only cores and flakes with a few scrapers (de Heinzelin et al., 2000). Yet in East Africa the Acheulian technology is dated to 1.65 ma at Kokiselei 4 (West Turkana; Roche et al., 2003), to 1.4 ma at Konso in Ethiopia (Asfaw et al., 1992) and to about 1.5 ma at Olduvai Gorge, middle Bed II (site EF-HR; Leakey, 1971).

In the Middle Awash, other sites in the Dawaitoli Formation with only core and flake technology and a good number of artifacts are dated to the early Middle Pleistocene (e.g. BOD-A3, DAW-A6 and HAR-A2). They occur at the same time and in the same area as sites with bifaces and cleavers (e.g.

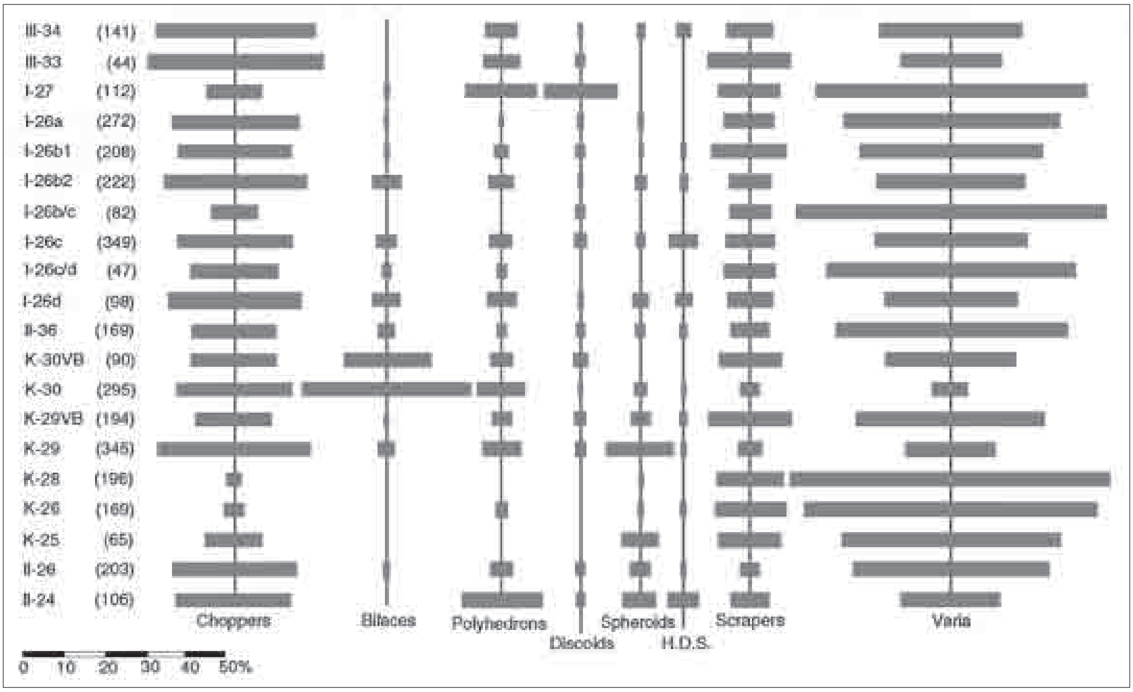

Figure 8. Tool frequencies in the 'Ubeidiya assemblages (after Bar Yosef and Goren-Inbar, 1993). Note the absence of bifaces in several assemblages.

HAR-A3 and HAR-A4). Clark and Schick (2002) believe that the so-called "Mode 1" assemblages are no more than a behavioral facies of the Acheulian Industrial Complex.

Other early Middle Pleistocene sites without bifaces are known in other parts of East Africa. For instance, the site of Nadung'a (West Turkana), dated to ca. 700 ka, has a large assemblage of 4000 artifacts in spatial association with a single elephant carcass. The formal tools consist of notches and denticulates and there are no bifaces at all (Delagnes et al., 2004).

Based on these observations, there is no reason to believe that different technologies must necessarily be associated with different kinds of hominins. Thus, it may not be necessary to invoke two separate migration events for the appearance of core-and-flake and Acheulian technologies in Italy. Nevertheless, we must admit that the current evidence is not sufficient to refute the alternative hypothesis of two or more migration events. To be sure, the African origin of both the core-and-flake and biface technologies cannot be doubted. We note that the skull from Ceprano (central Italy) is now considered a representative of an African population that migrated into Italy, perhaps at about 1 ma (Mallegni et al., 2003). As in Spain, the low density of early Middle Pleistocene sites fits a hypothesis of sporadic and discontinuous settlement of the Italian Peninsula; the density of sites only increases in the second half of the Middle Pleistocene.

The second half of the Middle Pleistocene

Although several assemblages with bifaces can be ascribed to the second half of the Middle Pleistocene, it is often not possible to be more precise about their ages and their chronostratigraphic position relative to each other. Many surface finds in the Venosa basin document the occurrence of bifaces on pebbles and rarely on flakes, but they are not in a stratigraphic context. The finds from the Atella basin, south of the Vulture volcano and close to the Venosa basin (which are possibly as old as Notarchirico), derive from limited test trenches along the shores of a paleolake and have provided thick bifaces made on cobbles of quartzitic sandstone associated with a larger series of small tools on flint flakes (Borzatti and Vianello, 1993). Assemblages from excavated contexts in various regions in Italy are often characterized by a very small number of bifaces and a larger proportion of flake tools and choppers. For instance, the site of Loreto in the Venosa basin is only slightly younger than the Notarchirico sequence. The main archaeological level (level A) occurs in the upper part of the Tufarelle formation, dated by correlation with the volcanic deposits of the Vulture volcano at about 500 ka (Lefevre et al., 1999), and contains a fairly large (if unspecified) number of flake tools and only one biface (Mussi, 2001). In Northern Italy the karstic doline of Visogliano has provided a few isolated human teeth and a mandible fragment. The stratigraphic sequence, dated by fauna to the middle part of the Middle Pleistocene (OIS 13–11) and excavated over a restricted area, has yielded a series of small assemblages; the lowest levels contain two bifaces together with 23 flake tools and a larger number of choppers (Abbazzi et al., 2000).

Many Acheulian occurrences, mostly in river valleys, have been reported from Tuscany and Umbria (central Italy); unfortunately, their age and stratigraphic context are unknown.

A few sites, all open-air, are documented from the Latium region (central Italy). They are as follows:

1) Fontana Ranuccio, 60 km southeast of Rome and excavated over 60 m^2, is dated by K/Ar to 458±5.7 ka. It has yielded five bifaces made on lava and flint, a number of small tools on flint flakes (no precise counts are available), a large biface made on elephant long bone, and a few more modified bones (Biddittu, 1993; Mussi, 2001).

2) Castel di Guido, 20 km west of Rome, is a sandy paleosurface excavated over about 1100 m^2, covered with stone artifacts and fossil bones. The vertebrate fauna include abundant *Bos primigenius* remains (NISP=2157) and *Elephas antiquus* bones (NISP=1459). There were 292 formal stone artifacts. These counts include 51 choppers, 153 small tools, 14 polyhedrons and 74 bifaces. The bifaces are made on limestone and flint pebbles; only four are said to be made on lava flakes. The counts exclude whole or broken cobbles and a few cores. There were also 163 reported flakes, but this is probably an underestimate due to the lack of screening during excavation. The site monograph (Radmilli and Boschian, 1996) also reports 99 bifaces made on elephant long bones, many utilized bone flakes and one ivory point; the latter is very likely a natural piece like the ivory points of Torralba and Ambrona (Villa and d'Errico, 2001). The number of 99 bone bifaces is definitely an overestimate, since many bone pieces were rounded and abraded beyond secure identification, but many pieces are well-made handaxes with symmetrical shapes and regular bifacial flaking (Figure 9). Together

Figure 9. Biface on elephant bone from Castel di Guido (central Italy), length 18.7 cm (after Radmilli, 1985).

with the biface and the bone tools of Fontana Ranuccio, the single bone biface of Malagrotta and the bone tools from La Polledrara, the Castel di Guido bone bifaces represent a very characteristic tradition of bone tool making in the Middle Pleistocene of the Latium region (Villa, 1991; Anzidei, 2001; Anzidei et al., 2001). Castel di Guido, which has yielded a few hominin cranial and postcranial remains showing a mixture of erectus-like and Neanderthal-like features, belongs, like La Polledrara, Malagrotta and Torre in Pietra level *m*, to the Aurelian Formation and is accordingly dated to OIS 9 (Mariani-Costantini et al., 2001).

3) At La Polledrara, also 20 km NW of Rome, about 400 stone artifacts made on siliceous pebbles have been found in association with numerous elephant bones. There are no bifaces at all, but seven large bone tools are made on elephant long bones. It has been argued that the flaking of elephant bone may be due to the difficulty of obtaining suitable raw material for the production of large artifacts (Anzidei, 2001; Gaudzinski et al., 2005). This seems to be the case for La Polledrara, where only small siliceous pebbles were available, but less clearly so for Castel di Guido, where relatively large limestone pebbles and other raw materials were available and used to make stone bifaces.

4) Torre in Pietra level *m* (excavated over an area of about 200 m^2) is similar to Castel di Guido in having a high proportion (29% of formal tools) of stone bifaces made on cobbles of limestone (30), flint (8) and siliceous limestone (4). The shapes are quite variable, but the level from which implements were collected was about 80 cm thick and the edge abrasion indicates that the artifacts are in secondary context.

By OIS 7 bifaces are either rare or completely absent at most sites. Torre in Pietra level *d*, excavated over about 40 m^2, is in fluvial deposits and like level *m* is clearly reworked. The total number of artifacts is 744; the Levallois technique is present and there are no handaxes. Other broadly contemporaneous sites within or in the vicinity of Rome (Monte delle Gioie, Sella del Diavolo) and various occurrences in northern Italy (e.g., Torrente Conca, Cave di Quinzano) are characterized by small flake tools, sometimes the use of the Levallois technique (in the two latter sites) and no or very few handaxes.

As this reviews shows, flake cleavers (in fact even bifacial cleavers) are rare in Italian assemblages. Two flake cleavers have been published from the open-air site of Rosaneto (Calabria, southern Italy) and are of sandstone (L=180 and 129 cm; Figure 10); two other pieces made of flint are bifacial cleavers from large-sized cobbles (Piperno, 1974; Segre et al., 1982). Since the layer originally containing the industry was eroded and the stone artifacts were found on the surface, the assemblage is undated. Typologically it can be attributed to the Late Acheulian, based on the regular secondary retouch on the lanceolate bifaces and on the small tools.

The Rosaneto occurrence shows that, although flake cleavers were part of the technical repertory of Acheulian craftsmen in Italy, they were not commonly used. It is possible that the relatively small size of the raw material blanks at various Latium sites and the scarcity of large quartzite cobbles (which seem to be the preferred raw material for cleavers, at least in western Europe, where large lava slabs or boulders are rare or nonexistent) may at least in part be the cause for this phenomenon. We note that in the two sites where bifaces are relatively common, such as Torre in Pietra level *m* and Castel di Guido, the mean length of bifaces is small compared to African assemblages from Bed IV and the Masek Beds, which contain both bifaces and cleavers. The mean length is 12±3.2 cm (N=42) at Torre in Pietra and 11.2±2.1 cm (N=49) at Castel di Guido. At Olduvai the flake cleavers from HK (hill wash later than the Masek), FLK Masek, WK and HEB West 2a, 2b, 3 (all in Bed IV) have a mean length of 13–16 cm (Roe, 1994). The mean length of the quartzite flake cleavers from El Sartalejo

Figure 10. Flake cleaver from Rosaneto (southern Italy) on a sandstone cobble, length 18 cm (after Piperno, 1974).

(Spain) is 14.2±2.2 cm and similar values are provided by the cleavers from Torralba and Ambrona. However, the flake cleavers from Campsas (Tarn valley, southwest France) made on quartzite cobbles have a mean length of 12±2.3 cm (Mourre, 2003), very similar to the mean length of bifaces from the Italian sites. Without an analysis of the flaking characteristics of the limestone cobbles used at Torre in Pietra and at Castel di Guido, it is not possible to establish if cleavers could or could not have been made on those blanks if so desired. At other sites, bifaces of slightly larger dimensions are known, e.g., at Colle Avarone in Latium where a number of rather large bifaces (mean length 14.3±3.7 cm) were made on limestone cobbles (Biddittu, 1974). Limestone was at times used to make cleavers; for example, in the Observatoire Cave in southern France, a few simple (type 0) flake cleavers were made on large flakes from oval limestone cobbles (Villa, 1983: 239–242). Siliceous limestone in the form of thick large slabs was quarried at Isampur in the Hunsgi valley (south-central India) to produce flakes for the manufacture of side-struck cleavers (Petraglia et al., 1999). Thus, the meaning of the scarcity of flake cleavers in Italy remains an open question, since it is difficult, in the absence of detailed raw material analyses, to define the role played by raw material size and flaking quality in the abandonment of a traditional tool form.

Northern France

The oldest dated occurrence of Acheulian handaxes in France is at Abbeville in the Carpentier Quarry, on the right bank of the Somme River in northern France. The sedimentary sequences of the Somme and Avre valleys, already recognized by Boucher de Perthes in 1847, has been the object of intensive archaeological and geological fieldwork promoted and directed by A. Tuffreau since the later 1970s. Recent work by Antoine suggests the presence of at least nine major fluvial stratigraphic groups (*nappes*) forming a terraced sequence, starting with the Nappe de Grâce, which has reversed magnetic polarity. The fauna, normal magnetic polarity and ESR dates (600±90 ka) of the Carpentier Quarry ("nappe de Renancourt") place it between OIS 16 and 15; the Acheulian industries of Saint-Acheul (rue de Cagny) and Cagny la Garenne are dated by ESR to OIS 12, between 450 and 400 ka (Saint-Acheul: 403±73 ka; Cagny la Garenne: 443±53 and 448±68 ka; Tuffreau and Antoine, 1995; see the papers by Van Vliet-Lanoë et al., Bahain et al. and Antoine in Tuffreau, 2001). At Cagny la Garenne the recent excavations by Tuffreau (the excavation area about 100 m south of the classic stratigraphic section, protected as a national monument, is called Cagny la Garenne II) have revealed a series of archaeological levels contained in gravels and fine lenses of fluvial silts of the beginning of a glacial period. The artifacts in the lower levels (unit K) correspond to activities linked to the selection of raw materials (flint nodules derived from the erosion of the nearby chalk talus). These activities are documented by a majority of unmodified blocks, blocks tested only by a few removals, discarded biface roughouts, and only 15% of flakes. In the upper series of levels (units J, I), activities linked to raw material procurement (testing of blocks, presence of unmodified nodules) are much less frequently represented in comparison to the quantities of debitage, products of shaping of bifaces, finished bifaces, small tools (often made on small flint slabs and dominated by notches with smaller numbers of denticulates and scrapers) and "heavy-duty" tools such as choppers and so-called "bloc-outils" i.e., flint nodules with few removals, similar to choppers. Although the Levallois technique has been recognized by Tuffreau, it is represented by very few cores (recurrent bipolar and with a preferential flake) and flakes. The debitage cannot really be defined as Levallois, since most cores have only one debitage surface and plain striking platforms. There are no flake cleavers and only one bifacial cleaver is described; the total of all levels is 9097 artifacts (including flakes and debris <2 cm; Lamotte and Tuffreau, 2001a). The proportions of bifaces in the total of formal tools vary from 3.1 to 18.4%.

The Levallois debitage is equally rare or non-existent in the series of Cagny l'Epinette, dated to OIS 9 based on terrace stratigraphy. While the microfauna suggested a younger age (OIS 7), one ESR date on the sediments of unit I (296±53 ka) supports the OIS 9 age estimate (Laurent et al., 1994). The site, situated on a terrace of the Avre, a tributary of the Somme, was excavated by A. Tuffreau for many years from 1980. Levallois cores and flakes comprise no more than 0.4% of the total assemblage and are too occasional to be significant; the bifaces comprise 6.4% of the formal tools in unit H, which overlies unit I. Proportions can be higher in levels of unit I, but the assemblages are relatively small. It should be noted that a good proportions of artifacts at both Cagny la Garenne and Cagny l'Epinette have clear edge damage due to the high energy of the fluvial environment; hence the integrity of the series is clearly doubtful. Counts provided here for both sites are based only on series of artifacts with fresh edges (Lamotte and Tuffreau, 2001b; see also Dibble et al., 1997).

Assemblages rich in bifaces and with a repertoire of flake types in many respects indistinguishable from Mousterian industries of Upper Pleistocene age are found during OIS 8 (e.g., Atelier Commont, Gouzeaucourt). At about the same time the Levallois method is documented in assemblages with rare bifaces such as Mesvin IV in Belgium, OIS 8, and Le Pucheuil série C in northern France, end of OIS 8 or beginning of OIS 7 (Soriano, 2000; Delagnes and Ropars, 1996) and slightly later in assemblages without bifaces at Maastricht-Belvedère in the Netherlands at about 250 ka, OIS 7 (Roebroeks, 1988). Levallois debitage is well documented at several sites from OIS 7 onward (Bapaume-les-Osiers, La Cotte St. Brelade, Biache; Soriano, 2000 and references therein). Flake cleavers have never been described from Acheulian assemblages of the Somme valley but only bifacial cleavers, i.e., handaxes with a transverse distal edge, which should not be confused with flake cleavers.

England

A few flake cleavers made on flint have been found in England: one in the Lower Thames valley at South Woodford (on gravels below silty clay, from a road cutting and found together with three handaxes and some flakes; Wymer, 1999: fig. 20), nine at Whitlingham near Norwich in East Anglia (in terrace gravels of the Yare River, where at least 200 handaxes were also found; Wymer, 1999: 133), one at Keswick (also in gravels of the Yare River, which yielded at least 175 handaxes), two at Baker's Farm and two at Furze Platt in gravels of the middle Thames valley (over 365 handaxes were found at Baker's Farm and 678 at Furze Platt), one in the Middle Gravels at Swanscombe and one at Cuxton in the Medway valley near the Thames estuary, a prolific site that yielded about 200 handaxes in a small area (Roe 1968a: p. III; Villa, 1983; Cranshaw, 1983; Wymer, 1999: 65–67, 133, 169, fig. 20; Mourre, 2003). The time range of these sites is OIS 11 to 8, but most sites are difficult to date precisely. Compared to the 39,000 handaxes recorded by D. Roe in his *Gazetteer of British Lower and Middle Palaeolithic Sites* (1968a), it is clear that flake cleavers are a very rare tool type in northwestern Europe. Bifacial cleavers, with a transverse edge often obtained by a tranchet blow, are less rare (Roe, 1968b); however, according to Mourre (2003: 251), bifacial cleavers cannot really be considered a functional replacement of flake cleavers, since their edges have morphometric features quite different from those of flake cleavers

Southern France

It is difficult to establish the antiquity of the Acheulian Technocomplex in southern France. The great majority of sites with Acheulian handaxes occur in river valleys, mainly the Garonne basin in SW France, very rarely in stratigraphic context and more commonly on the surface. In contrast to the situation in the Iberian Peninsula, knowledge of terrace sequences at present is inadequate, and consequently a reference framework for the chronologic ordering and linking of sites is lacking. Happily, the situation is changing due to an increase in studies associated with preventive archaeology (Bruxelles et al., 2003), but faunal data, paleomagnetic determinations and absolute dates are still rare or lacking and dating estimates are based on general typological features and even, for older publications, on the outdated Alpine chronology. Over a stretch of more than 100 km along the Garonne and the Tarn rivers, Acheulian findspots are very common; most are located on the Garonne and Tarn middle terraces or on equivalent terraces of their tributaries. In the Garonne valley bifaces and cleavers are made on cobbles of good-quality quartzite, which have regular oval shapes since they have been transported and rolled by the river over long distances from the Pyrenees.

In the Tarn river valley and in the Agout valley (a tributary of the Tarn), more than 100 findspots were identified and studied by André Tavoso; five thousand large and heavy duty tools (bifaces, cleavers, unifaces, choppers) are described in his work (1986). In the Tarn basin Acheulian bifaces and cleavers had to be made on materials of inferior flaking quality, quartzites, quartz and dolerites of the Massif Central and the Montagne Noire. However, at the interface between the two major river valleys (the Tarn enters the Garonne northwest of Montauban) Acheulian artifacts on the Tarn side are often made on imported Garonne quartzites. This raw material (greenish gray, fine-grained quartzite) was clearly desirable; the longest transport distance is indicated by the occurrence of artifacts of Garonne quartzites (N=6) among materials made on local quartzites of lower quality at the findspot of Labastide d'Anjou (on a terrace of the Fresquel, which flows toward the Mediterranean and is at the eastern edge of the Garonne basin; Féblot-Augustin, 1997: fig. 23). According to Tavoso (his thesis was written in 1978 but published only in 1986), the transport distance was 80 km, but he placed the source area near the confluence of the Tarn and Garonne; in fact the source could be farther south and in this case the transport distance would be in the order of 50 km (cf. discussion and maps in Féblot-Augustins, 1997: 85). Flint is available in this region, but is of rather mediocre flaking quality and blanks are rather small. The only good source of flint is in the Vere valley (a tributary of the Aveyron at the northern margin of the Garonne basin) and it was intensively exploited in the Middle Paleolithic, as documented by a number of surface sites with Levallois debitage and small MTA bifaces on flakes. To the east in the Causses and Quercy regions, Lower Paleolithic artifacts are made on quartz and bifaces are very rare; cleavers are totally absent (Jaubert, 1991).

Among the Tarn sites, the most interesting and well studied is Campsas, on the Tarn middle terrace at the border of the Garonne valley. Fifteen occurrences were identified and intensively collected between 1933 and 1959 by one person (M. Latapie). According to Tavoso, collections from different findspots are identical in composition, morphology and technical features. These findspots are very close to each other and it is not certain that each corresponds to a distinct occupation. For this reason the material from nine major occurrences was studied as one assemblage. Two interesting features characterize the Campsas assemblage:

1) A high proportions of flake cleavers among the large, heavy-duty tools (which include many cores, mostly discoid). There are 275 flake cleavers, i.e., 11.9% of the total (N=2310). Counts are based on Tavoso, 1986 and are slightly different from those in Villa, 1983.

2) A clear preference for the Garonne quartzite, which was available a few kilometers to the west. The Garonne quartzite was the favorite raw material for the biface/uniface group; 97% of the cleavers were made of this quartzite, while the Tarn quartzite was more commonly used for heavy-duty tools (choppers). This preference for the Garonne quartzite can be explained by the more irregular morphology of the Tarn quartzites, which makes it less suitable for the production of large and relatively thin flakes. The most common cleaver type is on cortical flake (type 0).

Other occurrences with bifaces and cleavers have been reported more to the south from the Arros valley (surface findspots) and the site of Lanne-Darré, both near Tarbes in the Pyrenean piedmont. Although Lanne-Darré occurs in colluvial sediments, the displacement seems relatively minor and the assemblage has been considered relatively homogeneous. Frequencies of flake cleavers (all made on quartzite) vary from 12.5 to 20.2% in the rather small series of the Arros valley and are more abundant at Lanne-Darré (42.4%; Mourre, 2003). Proportions of cleavers are calculated here in the same way as in the Tarn assemblages, within the total of large and heavy-duty tools, including cores. As at Campsas, cleavers are of the simple variety (types 0, I, II).

All these Acheulian assemblages are believed to be older than 300 ka, though this should be considered a "guess-estimate" rather than an established date. Assignments to specific time units (early Middle Acheulian, Middle Acheulian and Final Acheulian) are based only on typological evaluations. Internal seriation based on differences in physical conditions (a rolled series being older than a fresh one; Tavoso, 1986) is no longer considered a valid chronological argument.

Though it is clear that the Garonne basin, including its tributaries, was densely occupied in Acheulian times, it is difficult to locate *in situ*, undisturbed Acheulian occurrences. This seems to be tied to the fact that most occurrences are located on top of terrace gravels but were not quickly buried by fine-grained alluvial or loessic deposits, as in northern France; thus, materials were easily displaced by colluvial or alluvial processes. The silty deposits that sometimes occur on top of the middle and low terraces seem to be of recent age, definitely younger than the formation of the middle terraces (Jaubert and Servelle, 1996; Bruxelles et al., 2003). The rare excavations or test trenching of occurrences in stratigraphic context (En Jacca, near Toulouse on the Garonne middle terrace; Le Prône, a doline in the Tarn valley; Servelle and Servelle, 1981; cf. also Bruxelles et al., 2003) have not provided more precise dating information.

Terra Amata in SE France (Nice) has a low proportion of bifaces (less than 5% of the formal tools) and no true flake cleavers. There is a small number of unifacial or partly bifacial cleavers (N=11) that have a distal edge formed by a single "tranchet" blow (Villa, 1983). These pieces are made on fine-grained limestone pebbles and have been called the "Terra Amata type" in Table 3.

Acheulian bifaces rarely occur in caves and rock shelters. Figure 11 shows the frequency of bifaces on the total of formal tools at cave and open-air sites in France that are dated to older than OIS 7 or sites for which no firm age estimate can be provided but which can be typologically assigned to the Middle Pleistocene Acheulian rather than the Middle Paleolithic. For stratified sites layers are treated as separate units; only assemblages from excavations in stratigraphic context, or in one case from a controlled surface collection in a limited area (Combes; Turq, 2000), are included. Cave sites that have

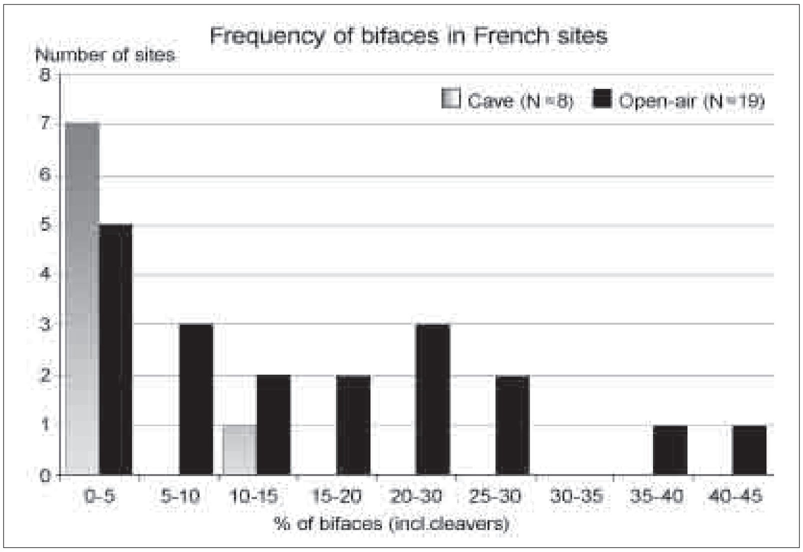

Figure 11. Frequency of bifaces (including cleavers) in the total of formal tools at cave and open-air sites in France. The sites are: Arago layers G, F, E, D; Lunel Viel; Montmaurin La Terrasse level 1 and 2; Orgnac level 6; Terra Amata stratigraphic units: Dune, Beach and Lower Cycle; Soucy 1 (Yonne, probable OIS 9); Nantet (Landes); Cazalège (Gers); Combes, La Plane et Bourg de Tombeboeuf (Lot et Garonne, Dordogne); Cagny l'Epinette levels H, I1, I1B; Cagny-la-Garenne levels I2, I3,I4, J, R1; Ferme de l'Epinette level MS (OIS 10). Data from Lebel, 1992; Le Grand, 1994; Moncel, 1996; Millet et al., 1999; Lhomme et al., 2000; Turq, 2000; Lamotte and Tuffreau, 2001a, b; Lamotte et al., 2001. Data on Nantet, Montmaurin La Terrasse level 1, and Terra Amata from Villa, 1983.

provided small numbers of bifaces in stratigraphic context are Arago, Lunel Viel, Orgnac 3 level 6 and Montmaurin La Terrasse levels 1 and 2; all these sites are located in southern France.

Orgnac is actually a karstic cavity that was first used by carnivores only, then its opening became larger through time and the cavity was accessible through a talus; the last human occupations correspond to an open air site. The human occupation sequence includes levels 8 to 1 and is dated to OIS 9 between 350 and 300 ka by ESR and U/Th (Moncel, 1996; 1999). Level 6 toward the base of the sequence contains a good number of carnivore remains (% MNI=7) and evidence of carnivore activity on herbivore remains but also abundant stone artifacts (N=2288). This level is in fact one of the numerous examples of sites with carnivore and human co-occurrences of Middle and Upper Pleistocene age in Western Europe (Villa et al., 2004). There are five bifaces on flint (1.9% of the formal tools); there are no flake cleavers and the assemblage is dominated by small tools on flint flakes or thin slabs. Orgnac 6 is clearly not the oldest Acheulian occupation in Southern France.

Three flake cleavers on quartzite occur at Montmaurin La Terrasse level 1, together with 13 bifaces and two picks. The site is in the Garonne basin (Mourre, 2003) and cannot be dated precisely. One biface is reported from Lunel Viel (Hérault, SE France); the assemblage is made predominantly on flint, quartzite, and quartz and the best-quality flint is the preferred raw material for producing Levallois flakes (Le Grand, 1994; the biface is unfortunately not described). Although the site is generically dated to about 350 ka, this is essentially a "guess-estimate"; however, the fauna suggest an age prior to the end of the Middle Pleistocene.

The site that has the best chance of being the oldest known occurrence of Acheulian tools in southern France is Arago Cave. Very low frequencies of handaxes (1.4% and less) have been reported from layers D, F and G (Middle Stratigraphic Complex, Unit III), which have yielded a wide scatter of dates based on different dating methods. U-series dates on the stalagmitic formation above these levels suggest a minimum age of >350 ka for those levels that contain the human remains (Falguères et al., 2004). Flake cleavers are reported but remain unpublished (Mourre, 2003). At the base of the Middle Stratigraphic Complex, layer Q is reported to contain bifaces (not yet published; Byrne, 2004); this stratigraphic unit is correlated to OIS 14. If the date is confirmed, this would be the oldest occurrence of the Acheulian in southern France. No bifaces have been reported for Soleihac (Massif Central), which is now dated to about 0.6–0.5 ma (Raynal et al., in Roebroeks and Kolfshoten, 1995).

Conclusions

The spatial distribution of flake cleavers

In Europe the distribution of cleavers coincides only partly with that of Acheulian handaxes. We should emphasize that flake cleavers are an integral part of African Acheulian assemblages in the sense that, although bifaces can occur without associated cleavers, cleavers always occur together with bifaces, and this already at the very outset of the Acheulian (see, for instance, the records of biface assemblages at Olduvai, Konso-Gardula, Olorgesailie, Isenya, Kalambo Falls; Callow, 1994: tables 9.1–9.2; Asfaw et al., 1992; Potts, 1993; Roche et al., 1988; Roe, 2001a, b). Thus it seems unlikely that the spatial distribution of flake cleavers is simply the result of different routes of expansion of Acheulian lithic technology out of Africa. Cleavers are made on large flakes and are most abundant in European regions in which the raw material occurs in the form of large quartzite cobbles that do not need extensive decortication and shaping prior to the removal of large flakes, as in the Spanish Meseta and in the Garonne and Tarn valleys of southwestern France. Elsewhere (northern France, England, Italy) cleavers also occur in different raw materials (flint or limestone) but are not common. Large, thick limestone slabs such as those used at Isampur (Petraglia et al., 1999) and lava blocks or boulders from which to extract large flakes as at Olduvai or Gesher Benot Ya'aqov (Jones, 1994; Madsen and Inbar, 2004) do not seem to occur in southwestern Europe. At the Late Acheulian site of Ma'ayan Barukh cleavers made of flint account for only 2% of the handaxe total and the majority are in fact bifacial cleavers, although several specimens are on flake and are made on Levallois flakes (Gilead, 1973). It is clear that raw material resources are an important factor in the abundance of flake cleavers in certain areas and their scarcity in others (Villa, 1983).

Main route of entry into Europe

There is no doubt that the Acheulian lithic technology was transported out of Africa. In Eurasia the Acheulian has a distinctive distribution spanning the area from the Iberian and Italian peninsulas to central Germany. North of latitude 52° and east of longitude 11° E in central Europe and the Russian plain, handaxe industries are conspicuously absent, occurring only sporadically in southeastern Europe (Kozlowski, 2003; Runnels and van Andel, 1993). Handaxe industries are again well documented in western Asia and as far as the Caucasus (Lioubine, 2002). Makers of typical Acheulian industries also traveled as far as the Indian subcontinent (Roe, 2001b). This distribution pattern, with peak densities in the west and the east and empty spaces in central and eastern Europe, is intriguing.

It seems likely that the route of entry for Acheulian people into Europe was from northwestern Africa via Gibraltar. Although this hypothesis has frequently been suggested (e.g. Tavoso, 1986; Roe, 2001b) there are arguments against it, such as the independence of fauna on both sides of the Mediterranean and the lack of proof of crossings in either direction between Africa and Iberia, even in the Upper Paleolithic. Evidence of navigation in the Mediterranean, including settlement of the Mediterranean islands, dates from late in the Upper Pleistocene (Mussi, 2001; Straus, 2001).

Yet the recently documented geography of the Acheulian outside Africa does suggest human expansion from both ends of the Mediterranean via western Asia and Gibraltar, with no evidence of linking routes across Europe. Population flows from Africa would have taken place at different times. Dmanisi in Georgia at ca. 1.8 ma (Vekua et al., 2002), south of the Caucasus, which would have constituted a true geographic barrier, marks the earliest record of dispersal into Eurasia prior to the emergence of the Acheulian. Other records of slightly younger age are known in Israel (1.4 ma), India (1.2 ma), Java (>1.5 ma) and China (1.66 ma) (Bar-Yosef and Goren-Inbar, 1993; Paddayya et al., 2002; Larick et al., 2001; Zhou et al., 2004). The first indication of an early crossing into Mediterranean Europe through Gibraltar is provided by the sites in the Orce region (ca. 1.3/1.2 ma) and Atapuerca (ca. 0.8 ma); their time range is well within the time frame of the Acheulian technology in Africa (Roche et al., 2003) and Asia (Goren-Inbar and Saragusti, 1996; Paddayya et al., 2002; Hou et al., 2000), although clear Acheulian occurrences in Europe are documented only after the beginning of the Middle Pleistocene. In sum, the European map presents the Acheulian as a late western/southern phenomenon; given its geographic distribution, it would be illogical to dismiss out of hand direct diffusion from the Maghreb and a hypothesis of a second or of multiple episodes of migrations into western Europe, perhaps during OIS 16 (659/620 ka), when a sea-level regression of 120–130 m would have allowed a water crossing of 10 km or less (Straus, 2001).

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